U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.

TELEPHONE CONSTRUCTION AND MAINTENANCE ON THE NATIONAL FORESTS.

INSTRUCTIONS FOR FOREST OFFICERS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1915.

CONTENTS.

ILLUSTRATIONS.

TELEPHONE CONSTRUCTION AND MAINTENANCE ON THE NATIONAL FORESTS.

INTRODUCTION.

Telephone communication is indispensable to fire protection and to quick and efficient methods of conducting National Forest business. After the transportation system has been reasonably developed, telephone communication should be given first place in improvement work. When completed, the telephone system on the National Forests will undoubtedly represent a very large investment, and every effort should be made to obtain the maximum efficiency and service.

The instructions contained in this manual are issued to secure standardization and uniformity in practice and methods, and should be followed in the construction of the line and the installation of equipment, unless otherwise ordered by the district forester. Deviations, however, may be made in the case of minor work and work of a temporary nature, if any are called for. Whenever considerable variation from the instructions is proposed, either in material or methods, the matter must first be submitted to the district office. The dimensions shown upon the illustrations will be followed as closely as conditions permit.

GENERAL POLICY.

Telephone lines are built and will be extended in the National Forests wherever their use will insure more effective fire protection and more economical administration, and where the territory covered is not served or probably will not be served by commercial lines on account of inaccessibility and absence of subscribers. In general, the telephone lines should be built between ranger stations and between lookout and ranger stations. Connections should be made to place the supervisor's headquarters in communication with each ranger and lookout. Where possible, the service of already established commercial lines should be used, and such connections made to their switch centers as will lessen the necessary construction of Forest Service lines.

NOTE.—This manual is a revision and amplification of and supersedes the unnumbered circular, entitled "Instructions for the Building and Maintenance of Telephone Lines on the National Forests," by C. H. Starkweather, jr., issued September, 1912. Several diagrams and most of the material on tree-line construction included in the present manual were supplied by R. B. Adams, Superintendent of Telephone Construction, District 1.

COOPERATION WITH COMPANIES AND INDIVIDUALS.

Cooperation between the Forest Service and companies or individuals which would involve joint ownership, construction, or maintenance of telephone lines introduces a division of responsibility which may affect communication and maintenance, as well as future growth and extensions, and therefore will not be entered into except in unusual instances, and then only with the specific approval of the district forester.

Commercial companies and settlers should be encouraged to build lines on and near the forests. The act of March 4, 1913, permits the free use of timber for the construction of telephone lines necessary for the protection of the National Forests from fire. Therefore in the cooperation with telephone companies and individuals it is proper for forest officers to issue free-use permits for poles to be used in the construction and maintenance of telephone lines in and near the National Forests whenever such lines will aid materially in fire protection. The general cooperative agreements with large commercial companies will follow the form which has been approved by the Secretary of Agriculture. (See Appendix.) Supervisors may continue to issue special-use permits for private or independent lines.

USE OF LINES.

Miners, settlers, logging foremen, and other persons needed in the fire plan of a Forest may be appointed per diem patrolmen and allowed telephone service free. As far as practicable, without overloading the line, other persons in the National Forests may be allowed telephone service under a schedule of charges to be approved by the district forester.

The number of telephones that can be allowed on Forest Service lines is of necessity limited. Each additional telephone increases the electrical load and lessens by this amount the reserve capacity for future growth, and more particularly for emergencies. Because of the unusual exposure to which Forest Service lines are subjected, leakage and resistance may be so great in emergencies as to require all the reserve capacity. There are times when it is necessary to signal over the line from outlying and lookout stations, or from portable instruments cut in along the line or operating over emergency lines. Forest officers should have these points in mind when considering applications for special-use permits covering the connection of non-Forest Service telephone instruments. As a general rule, such permits should not be issued on lines that will form a part of a circuit through a Forest.

Under usual conditions telephones directly tied in to the main line should not be closer than every 5 miles. These should be confined to

those used by forest officers or under permit by per diem fire guards. The Service will make its own installations and maintain them without expense to the permittees for the fire protection afforded.

Settlers, miners, and others off the main line who may have telephone service as just described, but who are nearer than the 5-mile interval, should be encouraged to build short branch lines at their own expense, under Forest Service standards of construction, and may be permitted to connect with a Forest Service line at a year-long station. When a branch line is so constructed, the settlers should be encouraged to form a company in order to provide for better service. A charge permit will be issued. Cooperative arrangements where connection with Forest Service lines is desired will be approved by the district forester.

IMPROVEMENT PLAN.

The plan for a telephone system will include a map and a report.

The map should show existing Forest Service and private lines and their character, and the location of exchanges and instruments, also the location and character of all new construction which will be necessary to meet the needs of Service business during the next five years. In addition, the map should show high-tension electric transmission lines, roads, trails, ranger stations, lookouts, and all other features which may influence the establishment of the system.

The report should discuss, in the order of their importance, the proposed new lines, their need, location, character, and cost. The telephone systems should be grouped by natural divisions, each being designated by its two terminals. A branch line should be designated by its terminal and the divisions of which it is a branch.

The district forester will prepare, from the information furnished by the supervisors, a map of the entire district, showing the existing and proposed lines. This will insure coordination of plans between the various Forests and with private systems. He will then issue instructions covering the general plan of the telephone system for each Forest.

STANDARD METHODS.

Since the Forest Service lines are primarily for fire protective purposes, they should embody the best principles of construction, and every precaution should be taken to insure continuity and dependability of communication over them at all times and especially during fire seasons.

In the building of a telephone line the point of first consideration is the country to be covered and the possible future connections to the system. Consideration can then be given to the type of construction and method of transmission.

The telephone wire may be strung either on poles or on trees. In open country and along cleared highways and trails the standard pole-line construction is preferable. The advantages of this type are simplicity of construction, uniformity of material, low cost of maintenance, neat appearance, straightness of line, and accessibility for inspection and repairs. However, when a pole line extends through timber, falling trees break the wire and pull off the brackets, thus rendering its service unreliable. To get the best results from a pole line through timber it is necessary to go to the expense of clearing a right of way, which is often impracticable. The insulation test of wire strung on brackets and insulators on a pole line is higher than for that placed on split insulators on a tree line, but the latter, when properly constructed, will give the better service in timbered country.

Tree lines should be constructed (1) where trees are plentiful; (2) where poles are scarce or inaccessible; (3) where rock, close to the ground surface, would cause expensive post holes; or (4) where the quality of the soil is such that the poles would last only a few years. The deciding factor is usually the cost of construction and maintenance. If sufficient funds are available and suitable conditions exist, a pole line should be constructed.

There are two methods of transmission—(1) by a grounded line, (2) by a metallic circuit. The former should ordinarily be used. The only advantage of the metallic circuit over the grounded line is in the elimination of cross-talk between lines and induction from power transmission and other lines. It will be used only where there is such outside interference. Usually the metallic circuit is not practicable on a tree line, owing to the chance of short-circuiting by falling trees. It may be used, however, after obtaining the approval of the district forester, whenever conditions seem to require it.

PRELIMINARY STUDY OF PROPOSED LINE.

FACTORS INFLUENCING LOCATION.

The relation of the proposed line to the telephone system, present and proposed, should be kept constantly in mind. This will influence the type and character of construction. If the proposed line is a trunk line, the possibility of connecting to it short branch lines from lookout points and ranger and fire stations should be considered.

The following additional points should be observed when locating telephone lines:

(1) The location of the most logical switching centers for connection with other lines.

(2) Topographical location. By avoiding steep slopes, cliffs, high divides, river beds, arroyos and streams, and canyons more than 500

feet in width, the danger from snowslides, landslides, floods, and high winds will be lessened. By following roads and main trails, frequent inspection will be facilitated and maintenance simplified.

(3) Location of other electrical circuits. Electric light, power, and high-tension transmission lines should be avoided whenever possible. A high-tension transmission line carrying over 5,000 volts should not be paralleled at a distance of less than one-half mile, and all crossings and approaches between telephone and power transmission lines should be at right angles.

(4) The probabilities of future growth and extensions.

(5) The length of the line. Other costs being equal, the cost of construction and maintenance varies as the line length.

SURVEY.

A preliminary survey or reconnaissance is necessary in order that the length of the line may be ascertained and its cost estimated. The thoroughness of the survey will depend upon local conditions. A transit line with chained distances may be necessary in some cases, while in others a walking or riding reconnaissance will be sufficient. The location determined by the survey, however, need not be taken as final; deviations from it should be made if it is found, during the course of construction, that greater reliability can thus be secured.

Whenever a pole line is to be constructed, either in whole or in part, marking stakes should be set in line at the proposed locations of the holes. Each stake should be marked to indicate the height of the pole for that particular position, the depth of the hole, the kind of hole to be dug—whether an anchor or a stub hole, whether the pole is to be guyed or braced, and the amount of the rake (fig. 1, p. 19) at curves and corners.

Each tree that is to be used should be blazed and marked with red chalk on the side to which the split insulator is to be attached.

RIGHT OF WAY.

If it is proposed to build any part of the line off the Forest, or over alienated land within the Forest boundary, right of way should first be obtained. The regular form, which will be furnished by the district forester, should be used. Verbal permission is not sufficient.

If it is desired to string wire on poles belonging to a private company, written permission should be secured before any construction is begun.

CLEARING RIGHT OF WAY.

When a pole line is to be constructed, a right of way at least wide enough for a bridle trail should be cleared through any dense underbrush or chaparral. Small trees directly under the wire line, which by their future growth might touch the wire, should be cut down at the outset. All trees and limbs, alive or dead, hanging over the cleared right of way, which would be likely to fall on, catch, or rub against the wire, or which might be borne down upon the line by wind or weight of snow, should be cut. Everything, in fact, that might at the present or in the near future cause trouble on the line should he cleared before or at the time the wire is strung. There should be at least 4 feet clearance from foliage on all sides of the line wire throughout its entire length. On account of the expense of clearing, dense growth should be avoided, though not at the sacrifice of a proper location for the line.

If the line is to be attached to trees, it is not advisable or necessary to top the trees to which the split insulators are fastened, except where the line has to cross over a windy canyon or in places exposed to a strong wind. Under such conditions the trees should either be topped or else poles used, preferably the latter. It is usually only necessary to trim the branches on the insulator side of the tree to a sufficient height for attaching the split insulator. Undergrowth between spans should be trimmed sufficiently to allow at least a 4-foot clearance of the line wire. Any dangerous snags or rotten trees in the close vicinity of the line should be cut.

The débris resulting from such clearing adds to the fire danger and should be gathered into piles and burned. If practicable, this should be done during construction work or shortly after its completion. If not practicable then, the brush should be piled and left for burning at a time when conditions are favorable.

ORGANIZATION AND EQUIPMENT OF CONSTRUCTION CREWS.

The foreman will be responsible for the work on the line in accordance with the instruction he receives. Whenever possible he should be a forest officer, carefully selected for his experience in telephone construction and in handling men. The size of the crew will depend upon the extent of the work, the qualifications of the individual members, and the time available for completion.

A crew may consist of a foreman, one ground assistant, two linemen, one utility man (swamper and lineman), and, if necessary, a cook. If more speed is desired, one or two additional linemen may be employed, provided arrangement is made to swamp the line and distribute materials with sufficient rapidity, to do which may require

one or two additional groundmen. Which members of the crew will dig the holes, which distribute the material, and which erect the poles will be determined by local conditions.

Each man employed in digging holes for poles should be provided with:

One 7-foot shovel, Western Union pattern.
One extra heavy, straight-handle, flat-toe spoon, Western Union pattern, 7-foot handle.
One 1-inch by 8-foot octagon steel digging bar.

Each lineman on tree lines should be provided with the following equipment:

One combination wire and sleeve splicing clamp. This is of the reversible type, one side being used for McIntyre sleeves and the other for Western Union connection.[1]
One pair 8-inch lineman's pliers.
One pair of Eastern climbers, with straps. These run from 14 to 19 inches in length by $\frac{1}{2}$-inch intervals.
One belt and safety strap.
One hand ax.

A construction crew on pole-line work should also be provided with:

Two Buffalo grips.
One Haven's steel clasp.
One 3-inch, double-pulley block (with one hook).
One 3-inch, double-pulley block (with hook and eye).
Thirty-five feet $\frac{1}{2}$-inch sash cord.

TRANSPORTATION AND DISTRIBUTION OF MATERIALS.

The wire, brackets, insulators, and other equipment should be conveyed from the railroad point or the place of purchase to the proposed line by automobiles, teams, or horses. Time and money will be saved if construction work is not started until all necessary line equipment has been distributed to its proposed location or to some convenient point. Wire and other metal should be kept off the ground.

It will often be necessary to pack the wire on horses. The maximum load for one horse is a half coil of No. 9 wire (weight 157 pounds). This may be packed on the horse in several ways, but the following method is suggested: Run a cross stick lengthwise between the crosstrees on the packsaddle, tying each end securely. Then split the coil of wire in half and place it over the top of the stick connecting the crosstrees so that one-half of the coil is on each side of the saddle. Finally throw a diamond hitch over the whole.

[1] Of standard make, Klein & Son pattern, or equal.

CONSTRUCTION OF POLE LINES.

SELECTION OF POLES.

Poles should be cut as near the proposed line as practicable. The best and most durable timber, such as the cedar, redwood, chestnut, tamarack, and Douglas fir should be used, if it can be obtained at a reasonable cost.

All poles should be cut from live or dead standing trees and should be free from heart or butt rot, or any other defect which might weaken them. As a means of reducing the cost of poles delivered at the hole it may in some cases be desirable to purchase poles from commercial companies.

Whenever possible poles and braces should be cut in winter to secure better seasoning. They should be peeled as soon as cut and all knots and branches trimmed close. Poles should be reasonably straight and of the following dimensions:

Length of pole.	Diameter of top.	Length of pole.	Diameter of top.
Feet.	*Inches.*	*Feet.*	*Inches.*
18	6	35	7
22½	6	40	8
25	6	45	10 to 11
30	6 to 7		

When a line will be subjected to severe stresses from high winds or unusual strains these diameters should be increased by from ½ to 1 inch. High poles should be of very fine quality. The butts of poles should be cut off square; the tops should be cut slanting on both sides to form a right-angle "roof" (fig. 4).

SKIDDING AND SEASONING.

It is sometimes possible to collect a number of poles or braces at one point as they are cut, and later to distribute them along the line without undue expense. In such cases the poles should be completely barked and piled in tiers, with a space of at least 6 inches between poles in the same tier and between tiers. The bottom tier should be of sufficient height from the ground to allow of the free circulation of air under the poles, which should be seasoned for at least two or three months. Seasoned poles are lighter and therefore easier to handle, and are usually more durable.

When it is not feasible to collect poles or braces at one point, the individual pieces should be peeled and raised off the ground or leaned against trees or rocks in an open position to season. Sound dead timber need not be seasoned.

PRESERVATIVE TREATMENT.

If durable woods can not be obtained at a reasonable cost, it may be necessary to give the poles preservative treatment. Before doing

this, however, the district forester should be consulted.[1] The poles of branch lines less than 3 miles long need not be treated in any case unless the branch is constructed at the same time as a treated main line.

There are several methods of treating poles, but the three following have proved the most successful. Before any treatment is applied all adhering bark, including the inner fibrous bark, should be removed with a drawknife from the portion of the pole to be treated.

(1) Open-tank method: Wherever practicable, this method of treatment is the best that can be employed. Creosote heated to a temperature not to exceed 200° F. is the preservative used.

(2) Standard Boucherie process: This process consists in forcing a preservative solution through the poles by hydrostatic pressure developed by having the preservative in a tank about 25 feet above the poles. Copper sulphate is employed.

(3) Brush treatment: This process requires less equipment than any other, but the results are not nearly so good as the open-tank method. A brief description follows: Hot creosote or hot carbolineum is applied to the poles with iron-bound brushes for a space of about 1 foot above the ground line and 2 feet below it, thus forming a band 3 feet wide. All seasoning checks and knot holes should be carefully filled and the preservative applied as freely as possible without waste, putting on all that the poles will absorb. After an interval of at least 24 hours the poles should be treated with a second coat applied in the same manner.

In hot, dry weather the creosote should be heated to a temperature of from 120° to 150° F. and in cold weather to 180° F. These temperatures, however, should not be exceeded. In heating the creosote the utmost precaution should be taken to prevent accidents. If the heating vessel is allowed to boil over or if creosote is spilled and allowed to burn on the outside of the vessel, the contents is pretty sure to ignite and burn fiercely. If creosote becomes mixed with water the mixture boils violently several degrees below the boiling point of the latter.

The preservative should never be applied to green timber nor when the surface of the pole is wet from rain, snow, frost, or is frozen.

The tops of the poles and the places where the brackets and braces are to be attached should also be treated with two coats of hot creosote, and the same is true of the butts of braces and the slanting top which is to rest against the pole.

A convenient outfit for brush treatment consists of a 5 or 10 gallon can or iron pot, a 3-gallon pail, ½-gallon dipper, a 4 or 5 inch wire-bound brush, and a thermometer.

---

[1] Also see Forest Service Bulletin 84, "Preservative Treatment of Poles."

LENGTH OF POLES.

The standard pole is 22½ feet long, and this dimension will be used in all but special cases. Poles shorter than 22½ feet may be used, with the approval of the district forester, provided the standard length is not available or for some reason is undesirable. When a line crosses solid rock, and when it would be cheaper, the use of 2 or 2½ inch wrought-iron pipes for short-length poles should be considered, notwithstanding their liability to rust. Such poles may be fitted into drilled holes, thereby making blasting unnecessary. There are several forms of commercial brackets and pins which, by the use of little ingenuity, may be set into the top of the poles or fastened to the side by carriage bolts.

Poles longer than 22½ feet may be used:

(1) Where the spacing of the poles is such that the required sag in the line would bring the wire too close to the ground.

(2) Where the underbrush exceeds 10 feet in height. Use poles that will keep the lowest wire at least 4 feet above the highest brush at the middle of the span.

(3) Where snow is likely to drift to depths exceeding 10 feet. Use poles that will keep the lowest wire at least 2 feet above the maximum height of the drift at the middle of the span.

(4) Where it is necessary to grade the line to overcome abrupt changes in level. There should not be an abrupt change; for example, from a 22-foot pole to a 45-foot pole, but instead, from a 22-foot to a 30-foot, and then by gradual lengthening of pole until the 45-foot length is reached.

(5) Where the line crosses wagon roads or railways. Use poles that will allow a clearance between the lowest wire of at least 15 feet above a road and 27 feet above a railway, measured from the middle or highest point of the road or track. Greater heights must be maintained if required by State laws. (See Crossings, p. 41.)

(6) Where necessary to cross over instead of under other pole lines. (See Crossings, p. 41.)

(7) At the ends of long spans (more than 500 feet) across rivers and canyons. Special poles or construction, approved by the district forester, should be used.

ERECTION OF POLES.

DISTRIBUTION OF POLES.

In distributing poles along a line, the heaviest ones should be selected for use on curves, at corners, at the ends of long spans, and at terminals.

SPACING.

On straight sections poles should be set 176 feet apart, which is equivalent to 30 poles per mile. For a grounded line carried on

poles, the distance apart, under favorable conditions, may be 200 feet, or about 26 poles to the mile. Changes in the direction of a line should be made gradually by spreading the curve over as many poles as possible, raking each pole outward to offset the strain. On curves and corners where the pull is from 10 to 30 feet, the pole spacing should be reduced to 100 feet. Where the pull is more than 30 feet, the turn will be made on two poles, approximately 100 feet apart, with equal spacings in the adjacent spans on either side. At right-angle corners the length of the section on either side next to the corner pole should not exceed 100 feet.

Where it is necessary to make a span of from 200 to 300 feet the adjacent sections should be 100 feet in length. Spans of from 300 to 500 feet should have two sections of 100 feet on each end. For spans of more than 500 feet special construction is required.

Where the line crosses solid rock the length of spans may be increased up to 300 feet to avoid the expense of blasting holes. When it is necessary to blast many holes, special construction may be desirable, and the matter should be taken up with the district office.

Abrupt changes in the level of the wire should be avoided. Poles should be set on either side of a high or low point, using long poles, if necessary, to obtain the desired clearance in the span. In crossing a ridge or ravine, for example, it is better to space the poles so that one is set each side of the ridge or ravine rather than to set a pole on the crest or in the bottom.

DIGGING HOLES.

On straight sections holes should be vertical, uniform in size from top to bottom, and at least 6 inches larger in diameter than the butt of the pole. This will permit the earth to be evenly tamped around the pole for the total depth of the hole. In general, the depth of holes for various sizes of poles should be that shown in Table 1. On curves or in soft soils, however, holes should be at least 6 inches deeper than the figures given.

TABLE 1.—*Size of hole for different lengths of pole.*

Over-all length of pole.	Depth of hole.		Over-all length of pole.	Depth of hole.	
	In earth.	In rock.		In earth.	In rock.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
18	4	3	35	6	4½
22½	4	3	40	6½	5
25	4½	3½	45	6½	5
30	5	4			

On a hillside the depth of a hole should be measured from the lowest side of the opening. Where the hillside is so soft that the pole may possibly kick out, the depth of the hole should be determined by the foreman.

Where it is not possible to dig the required depth, the hole should be blasted. If this is not feasible, the pole should be securely braced or guyed.

ATTACHMENTS TO POLES.

Standard brackets with insulators and all other equipment which is to be attached to the pole should be put in place before the pole is erected.

Pole steps.—Steps should be used on all poles over 30 feet high or to which telephone apparatus, such as switch boxes and test stations, are attached. The steps are of galvanized iron, $\frac{9}{16}$ by 9 inches. They should be driven alternately into the opposite sides of the pole, parallel to the direction of the line, and spaced 18 inches on centers. The line of the steps should be parallel to the center of the poles.

Glass insulators.—Glass insulators of the type known as regular pony long-distance type, weighing approximately 14 ounces each, and conforming to the specifications of the American Telephone & Telegraph Co., should be used on all lines built of No. 9 wire when strung on poles. No. 9 pony glass may be used for all lines built of No. 12 wire strung on poles.

Brackets.—On a one-wire line the brackets should be placed on the same side of all poles, except that at corners or curves they should be on the side of the poles away from the center of the curve, so that the line wire will pull them against the poles. Brackets should be nailed to the poles with one 60-penny and one 40-penny galvanized-iron wire nail. For one-wire lines the top bracket position will be used.

It is not necessary to shave the pole at the place where the bracket is attached.

On straight section of a two-wire line the brackets should be on opposite sides of the poles, but on curves both brackets should be on the side of the pole away from the center of the curve (fig. 4).

As an additional safeguard whenever a line crosses the tracks of a railroad, two brackets with insulators placed side by side should be used on the first pole on each side of the track. Where a line is attached to a large pole at a sharp corner two brackets slightly separated will be used, in order to keep the line wire clear from the pole.

Lightning rods.—Lightning rods should be placed on poles before they are set. In ordinary situations a rod should be placed on every tenth pole.

In exposed, mountainous regions, or where the line crosses mountain ranges or divides, a rod should be placed on every fifth pole. It

should be the same kind of wire as the line, and long enough to reach from 6 inches above the top of the pole to about 3 feet below the bottom. The upper end of the wire should be bent back about 3 inches from the end and given several turns about itself; the lower end should be made into a small coil of three or four turns, 5 or 6 inches across, at the bottom of (not around) the pole. The rod should then be attached to the pole with 2-inch staples at intervals of 3 feet, at a point one-fourth the distance around the pole from the bracket, running in a straight line to the ground, the upper end projecting about 3 inches above the ridge of the pole. The wire coiled at the bottom should be bent into place or stapled at the bottom of the pole so that the latter, when set, will rest on the coils.

After the pole is set and the line wire attached, an inspection should be made to make sure that there is no contact between the lightning-rod wire and the line wire.

Lightning rods are not necessary in tree line construction.

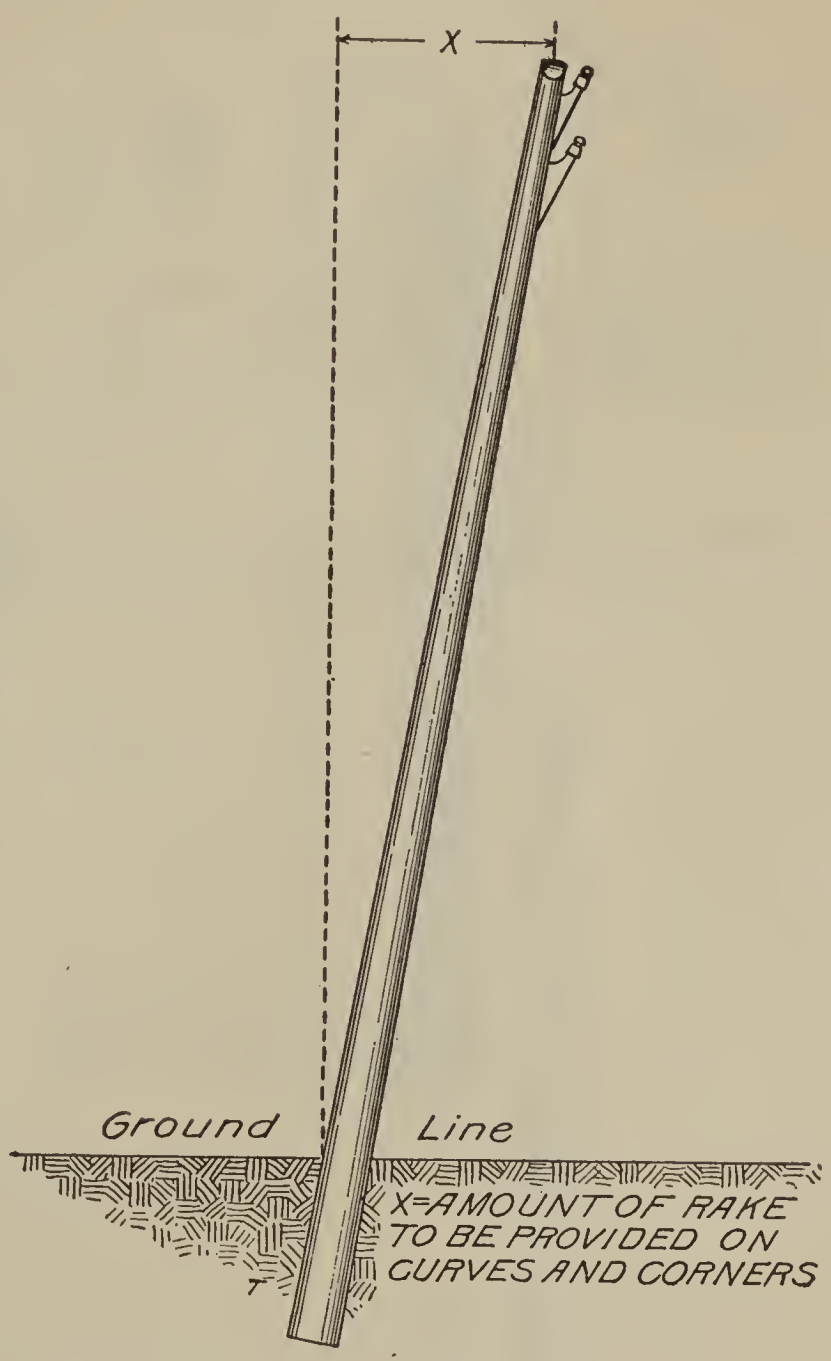


FIG. 1.—Definition of rake.

SETTING POLES.

On straight sections poles should be set vertically.

On curves or at corners the poles should be placed so that they will incline outward from the center of the curve (fig. 1).

When the pull is less than 5 feet the rake should be about 10 inches (fig. 2); with a pull of from 5 to 10 feet, 15 inches; and with more than 10 feet, about 25 inches. These figures apply to the top of the pole after it has been set and before the line wire is attached. Warped or crooked poles should be set so that the crookedness will offset the pull of the line wire at the ends of long spans or on curves or corners. No attention need be paid to the possibility of the line wire changing the amount of rake. These specifications are approximate and may

be exceeded without harm. Rake is sometime necessary even though the pole is braced or guyed.

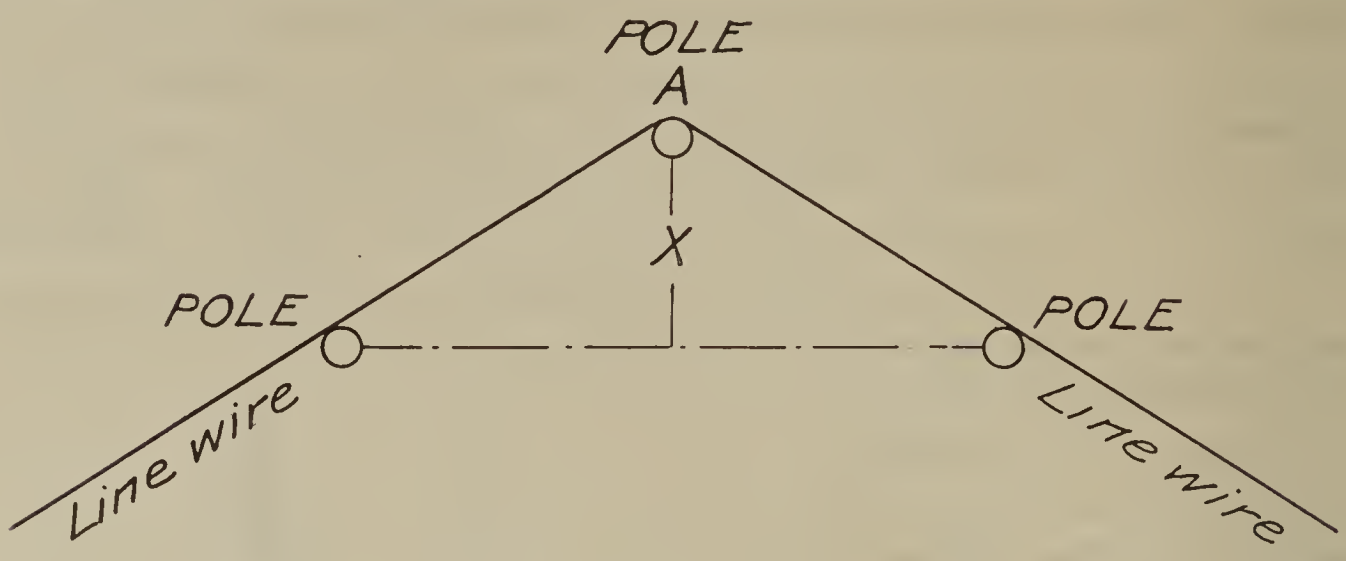


FIG. 2.—Definition of pull.

Poles should be set with the roof ridges at right angles to the line wire, except when cross arms are used, in which case the ridge will parallel the line. The bracket should be exactly at right angles to the line, and in the proper position to prevent the line wire from touching the pole.

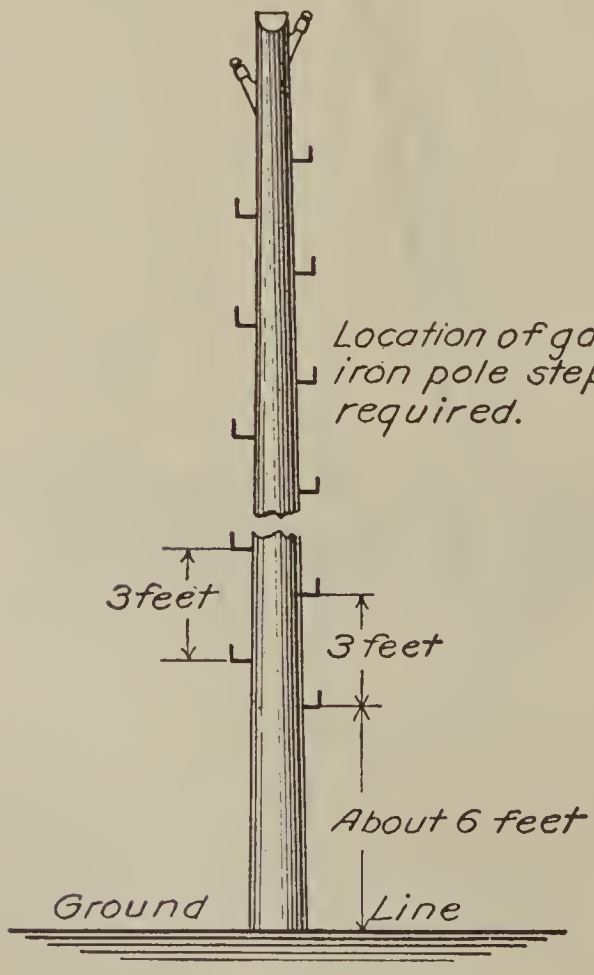


FIG. 3.—Pole steps.

FILLING AND TAMPING.

In setting a pole it should be "trued" and held in position until firm, the dirt being filled in evenly around it and thoroughly tamped as the filling progresses. The coarse soil or gravel should be put in last. The filling can be done by one man, and the tamping by two men. After the pole is set and the hole filled, about 6 inches of earth should be closely packed around the pole above the ground. Poles set in solid rock should have rock fragments firmly wedged in around them.

BRACING AND GUYING.

The use of braces and guys is obviated in many cases by a proper amount of rake, but either bracing or guying will be necessary in the following cases:

(*a*) On any pole on a curve or at corner where the pull exceeds 30 feet.

(*b*) On poles at each side of a crossing over roads and railroad rights of way.

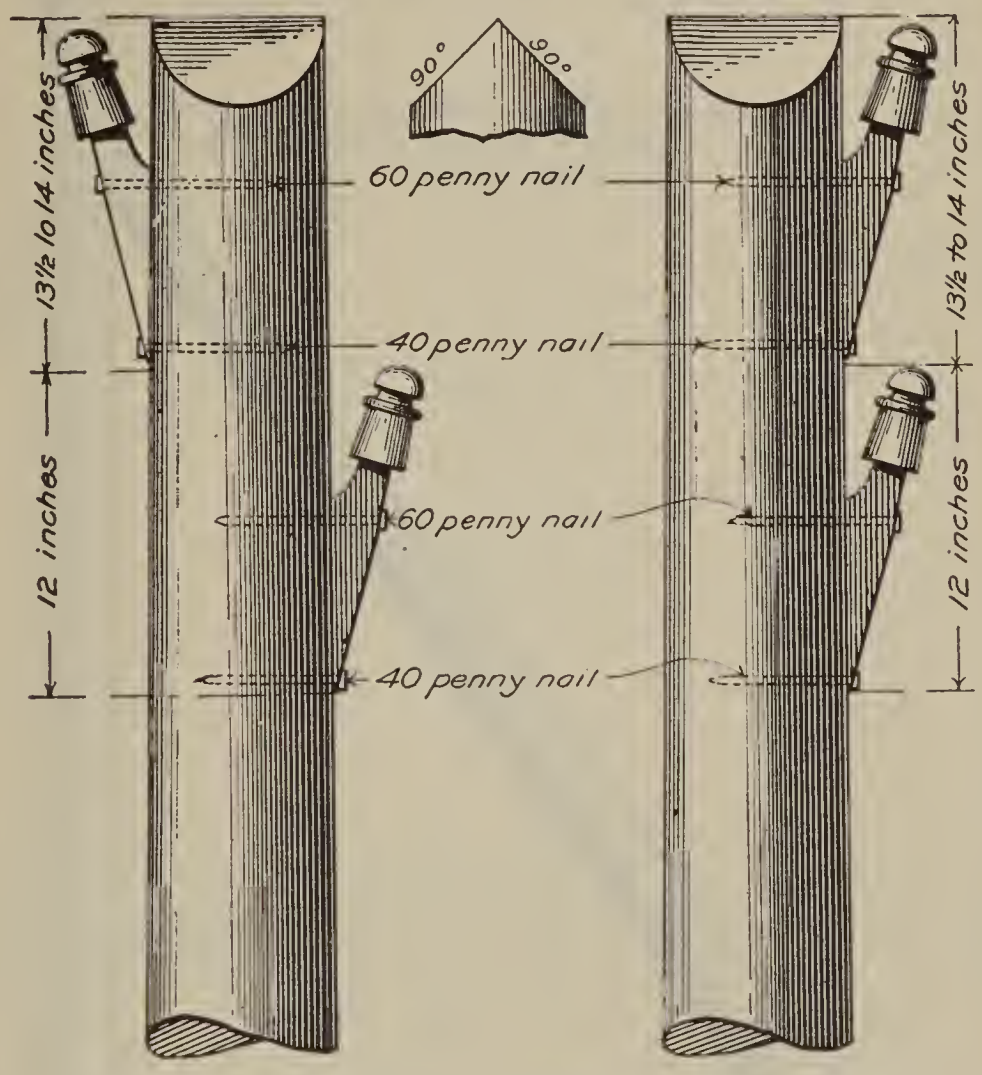


FIG. 4.—Location of brackets on pole.

(*c*) On the two end poles of spans between 300 and 500 feet.

(*d*) On the poles at either end of spans above 500 feet.

(*e*) On very steep slopes. Anchor guys may preferably be used in these cases, or a head guy from the top of one pole (below the lowest bracket) to the base of the pole next above it.

(*f*) On alternate poles in exposed positions.

(*g*) On poles in swamps or on loose ground (where necessary).

(*h*) On poles on both ends of high tension transmission line crossings.

(*i*) On the first and last poles of a line.

BRACES.

Braces (fig. 5) should be at least 8 inches in diameter at the butt end, cut slanting at the top to fit close to the pole, but the pole

itself should not be cut. They should be set at least $2\frac{1}{2}$ feet in the ground; $3\frac{1}{2}$ feet would be better, if too much difficulty is not encountered in digging. The distance between the brace and the pole, as measured on the ground, should be not less than one-half of the height of the pole above ground. The bottom end of the brace should

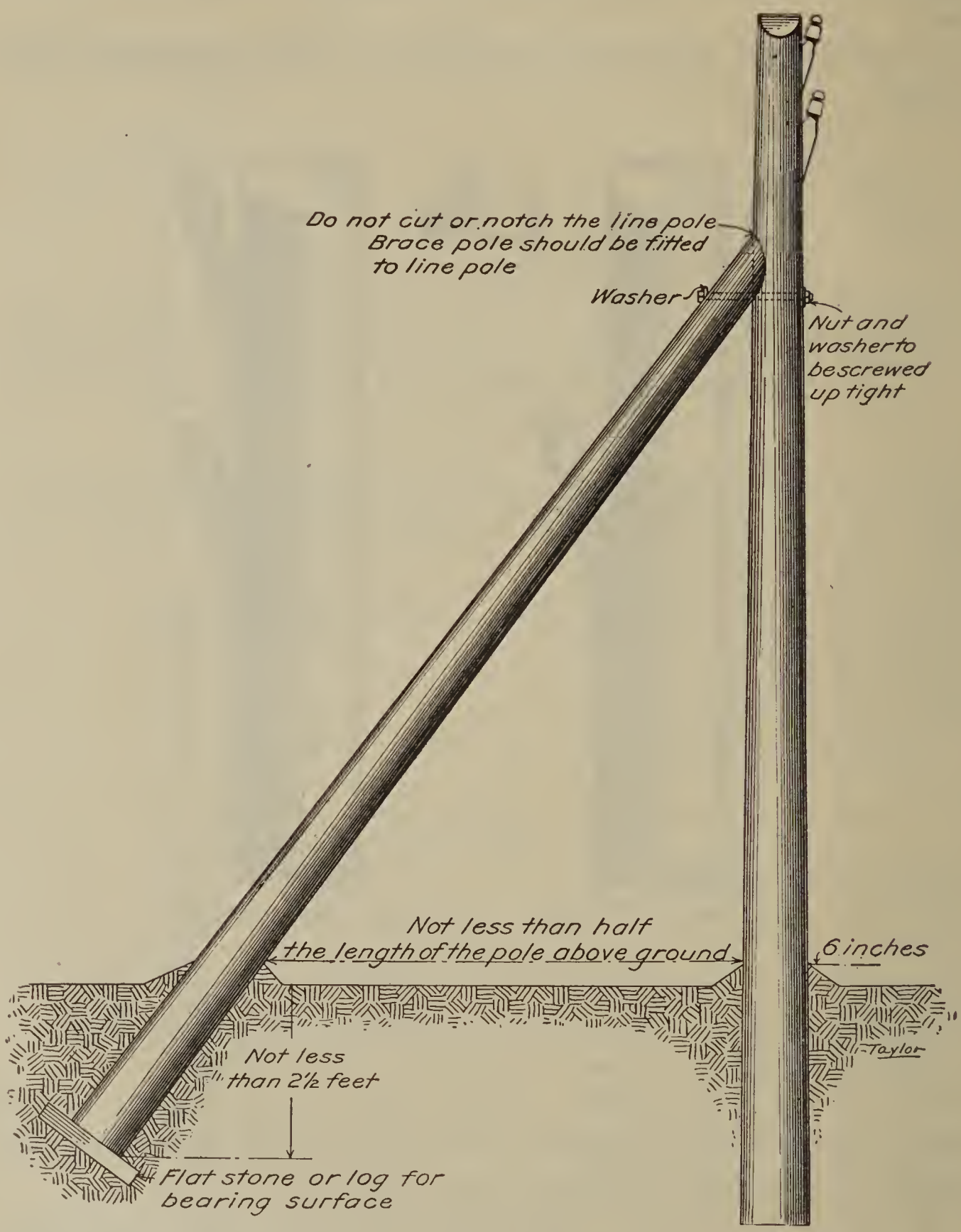


FIG. 5.—Method of bracing.

rest on a flat stone or piece of log or plank. After boring a $\frac{5}{8}$-inch hole through both the brace and the pole just above the point where the bottom edge of the former touches the latter, the brace should be bolted tightly to the pole with a $\frac{5}{8}$-inch galvanized-iron bolt, using a $2\frac{1}{4}$ by $2\frac{1}{2}$ by $\frac{3}{16}$ inch galvanized-iron square washer under both the head of the bolt and under the nut.

GUYS.

Anchor guys (fig. 6) should be made of two pieces of line wire (No. 9 B. W. G.) twisted together, and, if possible, of sufficient length to reach from the bottom of the lowest bracket to a point on the ground at a distance from the bottom of the pole equal to the latter's height above ground, but under no condition less than 6 feet, with enough additional length to allow one end to be passed through the eye of a standard half-inch galvanized-iron guy rod, the other to be wrapped twice around the pole, and both secured.

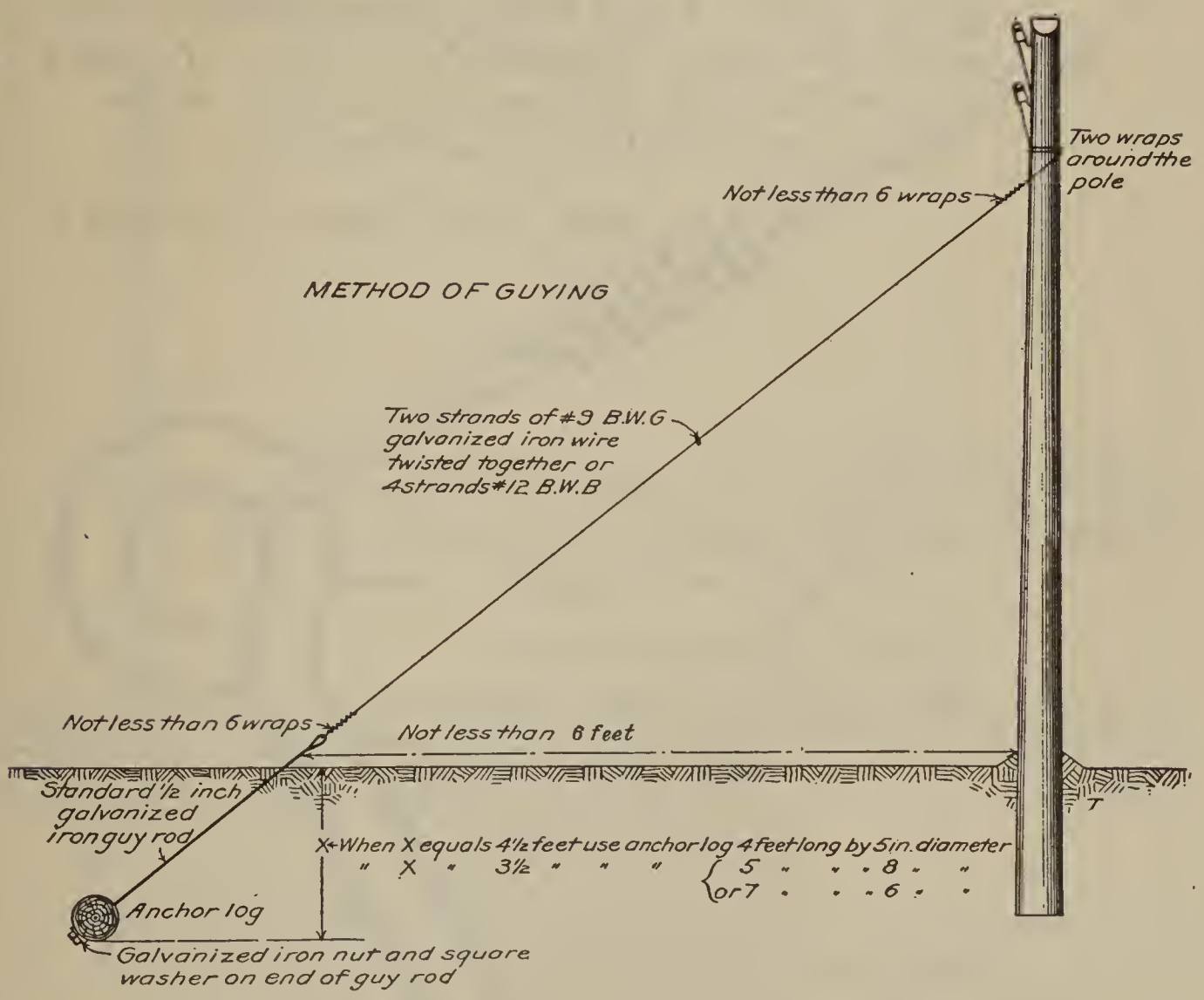


FIG. 6.—Method of guying.

When a guy has been prepared, one end should be wrapped around the pole twice and stapled, the loose end being secured by wrapping not less than six times around the wire, using a pair of connectors or pliers. An anchor log should then be placed in the ground with a guy rod passing through it, the eye of the rod projecting above the ground. One of a pair of pulley blocks should then be hooked into the eye and the other fastened to a Buffalo grip or a medium-sized Haven clamp attached to the guy wire. The latter should then be pulled to the required tension and the end looped through the eye and secured by not less than six wraps (fig. 7), after which the pulley blocks and Buffalo grip can be removed.

The size of the anchor log will usually be determined by its depth below ground, as follows:

Depth of excavation.	Dimension of anchor log.	
	Length.	Diameter.
Feet.	*Feet.*	*Inches.*
4½	4	6
3½	5 or 7	8 or 6

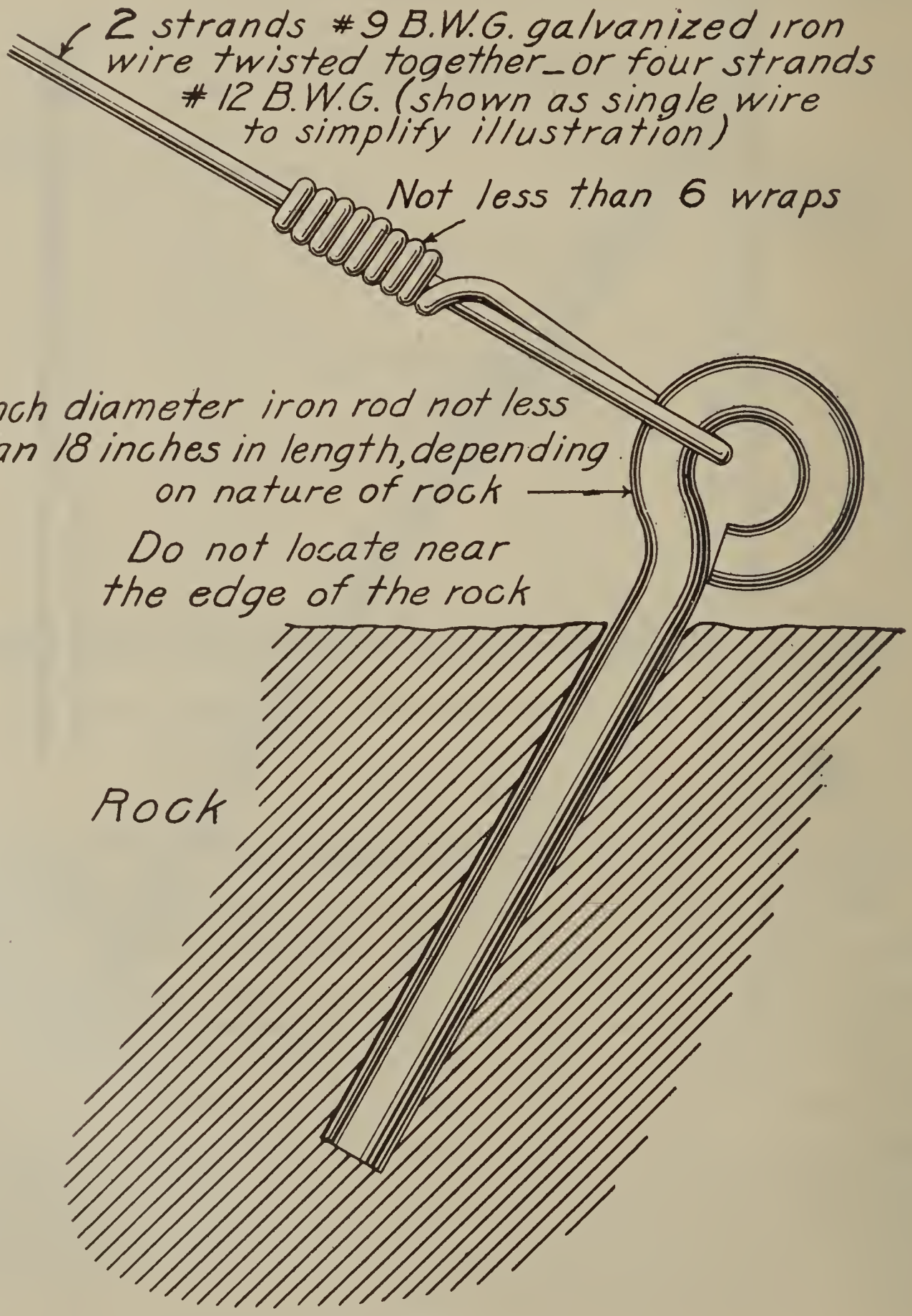


FIG. 7.—Rock guy bolt.

If guy rods are not available, the guy wire should be wrapped around the anchor log. This is temporary construction, as the guy wire will rust and break.

When a guy is used on a public highway or street in a city or town, a guard should be used to make it readily visible. For this purpose it may be boxed up to a height of 6 feet above the ground, or a sapling about 3 inches in diameter may be wired to it.

Tree guys.—If there is a live tree of large diameter near by, the guy wire may be fastened to it instead of to a buried log. Hardwood slats should be used between the guy wire and the tree to prevent injury to the latter.

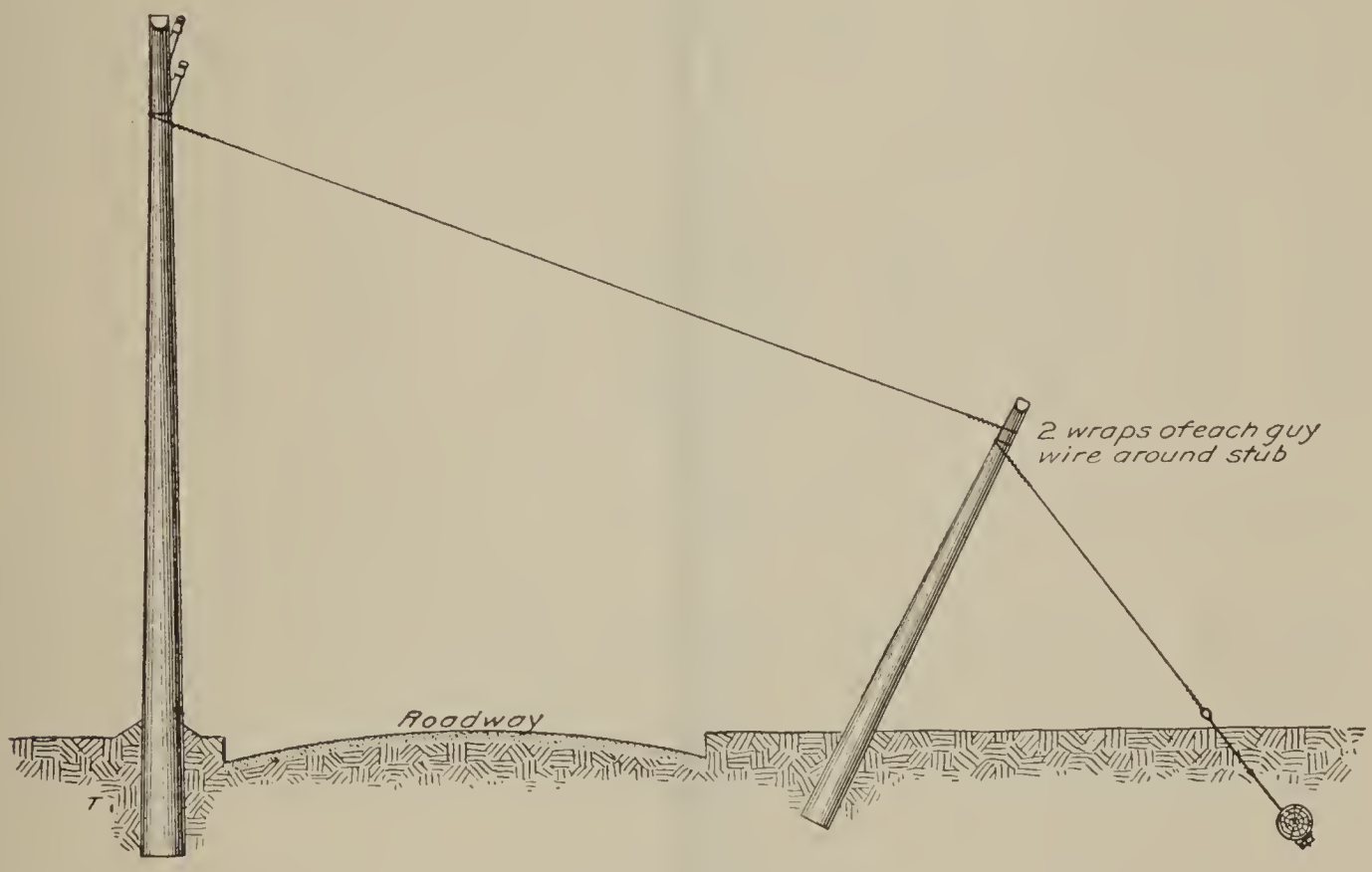


FIG. 8.—Method of using guy stub.

Rock guys.—A homemade iron eyebolt 1 inch in diameter and not less than 18 inches long may be used for anchoring a guy wire in rock. The angle formed by the guy wire and the shank of the bolt should not be more than a right angle. (Fig. 7.) The bolt should not be near the edge of the rock or ledge.

Guying across roads.—If a guy wire as ordinarily placed would interfere with traffic on a road, a stub should be used (fig. 8) to provide proper clearance. The stub should be stayed with the standard guy rod and anchor log; or, if this is not possible, braced with anchor logs underground, as shown for the pole in figure 9.

SELF-SUPPORTING POLES.

Where conditions prevent the use of any other method of guying, and especially in swampy soil, the poles should be braced with anchor logs, as illustrated in figure 9.

LINE CONSTRUCTION.

Iron wire is divided into three grades: Extra-Best-Best, Best-Best, and Steel. The Extra-Best-Best (E. B. B.) wire possesses the highest conductivity, but the lowest tensile strength. It is designed

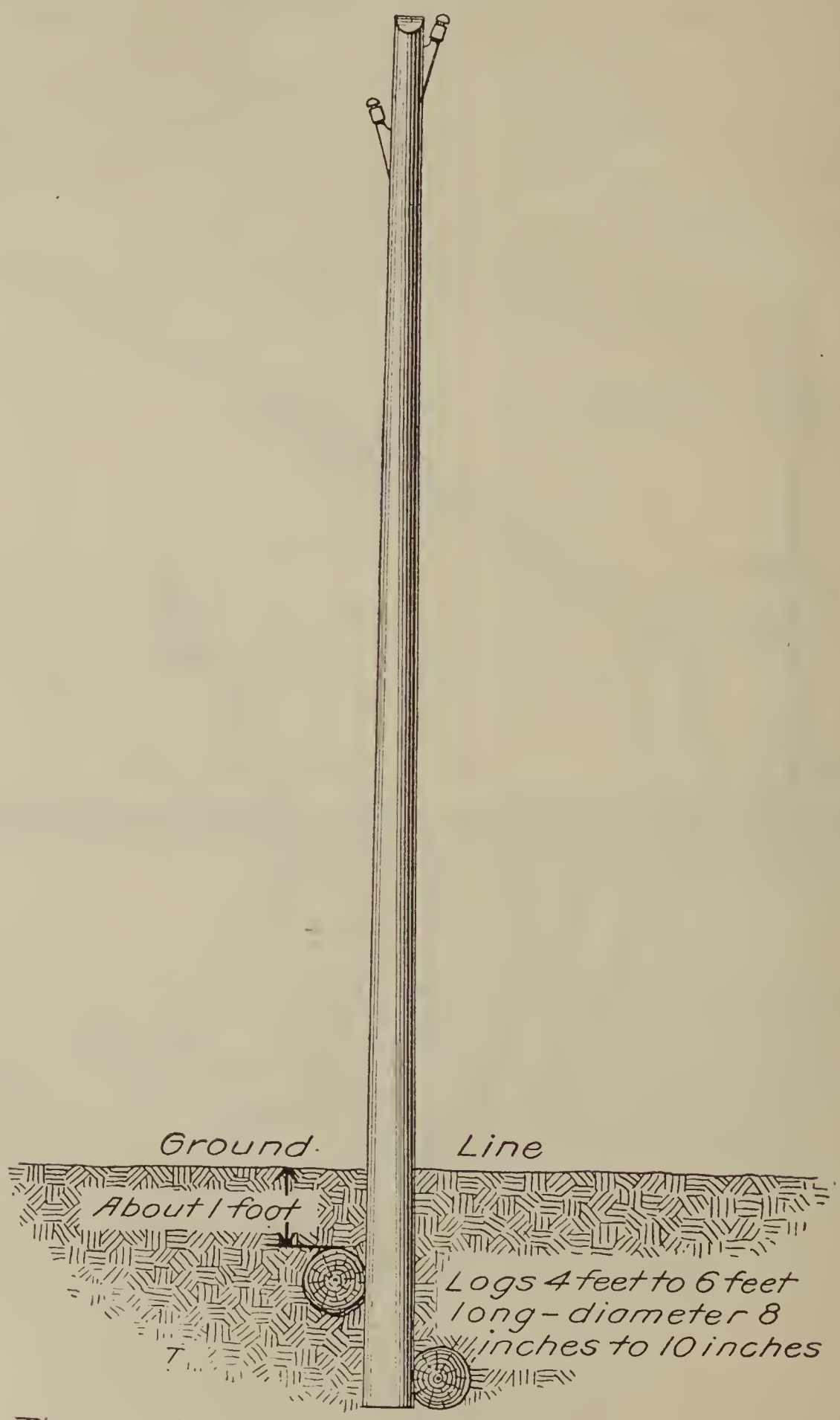


FIG. 9.—Method of ground bracing.

for use on the main lines of telegraph companies, and by telephone companies where a wire of high conductivity combined with strength and toughness is required. The steel wire is made from a special grade of material. It is the lowest in conductivity, but highest in tensile strength. The Best-Best (B. B.) wire, which possesses intermediate qualities, is more generally used than the others on medium distance circuits by telephone companies and for railroad work.

Table 2 [1] gives the physical characteristics of these three grades of wire:

TABLE 2.—*Properties of double galvanized telegraph and telephone wire.*

Number Birmingham wire gauge.	Diameter in inches.	Weight in pounds per mile.	Put up in bundles of—	Approximate breaking strength in pounds.			Average resistance in ohms at 68° F.		
				E. B. B.	B. B.	Steel.	E. B. B.	B. B.	Steel.
			Mile.						
4	0.238	811	¼	2,433	2,676	3,000	5.98	7.15	8.32
6	.203	590	⅓	1,770	1,947	2,183	8.14	9.83	11.44
8	.165	390	½	1,170	1,287	1,443	12.43	14.87	17.31
9	.148	314	½	942	1,036	1,162	15.44	18.47	21.62
10	.134	258	½	774	851	955	18.80	22.48	26.16
11	.120	206	½	618	680	762	23.54	28.15	32.76
12	.109	170	½	510	561	629	28.53	34.12	39.70
14	.083	99	½	297	327	366	49.00	58.58	68.18

All iron wire should be well galvanized to protect it from the corrosive action of the weather.

Hard-drawn copper wire possesses great conductivity and high tensile strength and does not deteriorate when exposed to the weather. It is therefore well adapted for telephone lines. More difficulty is encountered, however, in obtaining good electrical joints when splicing copper wire than when splicing iron wire. Copper wire is of particular value where unusual construction is required, such as on very important trunk lines, on lines over 125 miles in length, on metallic circuits, etc.

STANDARD CONSTRUCTION.

A one-wire line (grounded circuit) of No. 9 B. W. G.[2] Best-Best galvanized-iron wire will be the standard construction on the National Forests. No other method should be used unless the permission of the district forester is first obtained. If the line is located outside of the Forest where there are no trees, No. 12 B. W. G. galvanized wire may be used, provided the length is short. Metallic circuit lines are used only where there is outside interference, such as cross talk, induction, or trouble from power-transmission lines. It is not possible to talk any farther over a metallic circuit line than over a grounded circuit line provided the grounds are made properly.

[1] Summary of tests by John A. Roebling's Sons Co.

[2] Birmingham wire gauge.

Where the length of a line exceeds 125 miles, it will probably be necessary to use copper wire. This can not be used with swinging insulators and will not be employed except on a strictly pole line. Where necessary, a two-wire line (metallic circuit) of copper wire may be used.

For spans up to 500 feet the galvanized-iron wire should be used, except when the circuit is of hard-drawn copper wire. For longer spans steel wire or other forms of special construction will be necessary. No. 12 N. B. S. G.[1] hard-drawn copper wire should not be used on spans longer than 300 feet, nor No. 14 N. B. S. G. hard-drawn copper wire on spans longer than 200 feet. If the circuit is of No. 12 N. B. S. G. hard-drawn copper wire and it is necessary to make spans longer than 300 feet, No. 8 N. B. S. G. hard-drawn copper wire should be used for the spans from 301 to 500 feet. If the circuit is of No. 14 N. B. S. G. hard-drawn copper wire and it is necessary to make spans longer than 200 feet, No. 12 N. B. S. G. hard-drawn copper wire should be used on spans from 201 to 300 feet.

CAUTIONS.

Great caution must be used during lightning storms. While lightning is being discharged in the vicinity of the work and as long as there is any danger from this source, no line wire or any wire electrically connected should be handled or touched.

A pole should never be climbed unless it is first tested to see that it is secure. Butt rot below the ground line renders poles insecure that to the casual observer appear strong. This is especially true when the line wire or guy has been removed.

STRINGING WIRE.

There are several satisfactory methods of removing the wire from the reel, and which one to use will be determined by the conditions in each particular case. A man familiar with the location of the line and with the transpositions should be in charge of the unreeling of the wire. In paying out the wire care should be taken to place it on the proper side of poles or trees, in order to avoid cutting it. Splices should be as few as possible.

When the conditions permit the use of a wagon, the reel may be placed in the back and the wire laid upon the brackets as fast as the wagon proceeds.

Another method is to have the wire pulled out by a horse, either with a rope between the ends of the wire and the traces of the horse that can be let go instantly, or by tying the end of the wire to the horn of the saddle, with a man watching the reel. Where the line

[1] New British standard gauge.

is very crooked the reel should be placed at less than one-half mile from the starting point.

Instead of using a wagon or horse, the wire may be unreeled by three men, one of whom should be stationed at the reel to see that the wire is not paid out too fast, or to signal in case it becomes kinked or tangled.

Another method in National Forest work is for two men to carry the reel, paying out the wire as they go. This should only be used in stringing copper wire, as this wire should never be dragged on the ground.

Wire should not be paid out from a coil held by one man, since it comes off badly twisted and is likely to kink.

Hard-drawn copper wire must be handled much more carefully than galvanized-iron wire. The coil should not be thrown from a wagon to the ground. Before commencing to unreel it, the first 15 or 20 loops of the coil should be carefully lifted by hand to guarantee

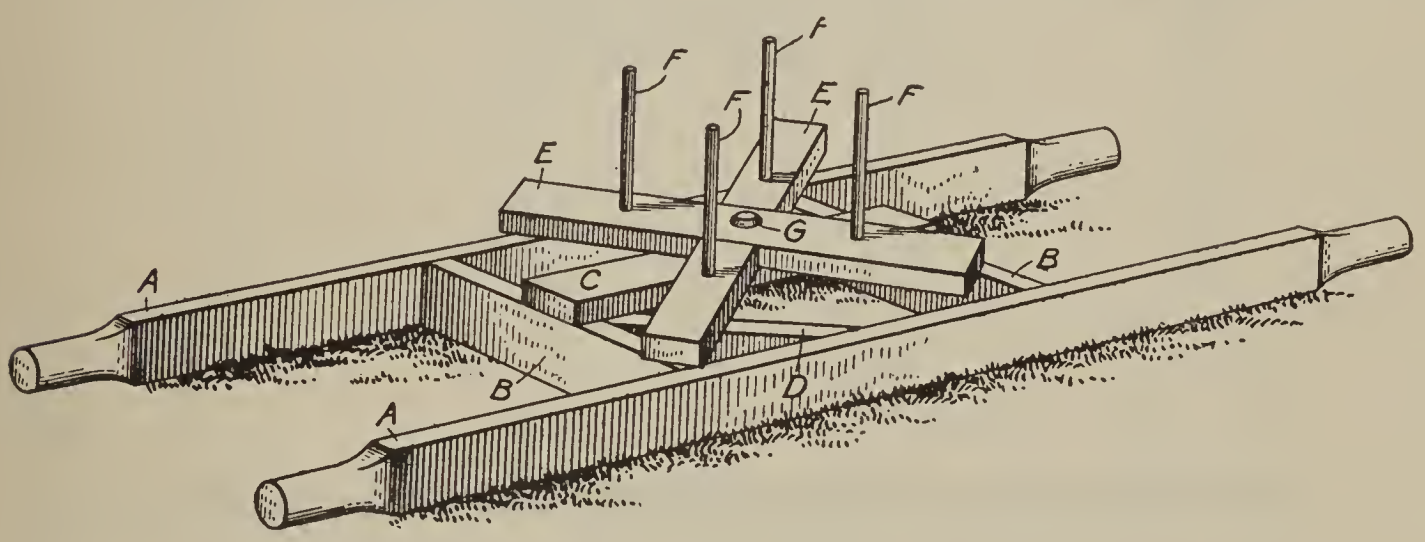


FIG. 10.—Home-made reel.

that there are no "crossovers." Hard-drawn copper wire should never be dragged on the ground while being strung. If a wagon can not be used to carry the reel, it should be carried by several men.

The pay-out reel handled by the supply houses is of hardwood bound with iron straps. Its weight precludes its use on lines following trails and through timber. A homemade reel is much lighter and less expensive. This consists of two parts, a support and the reel proper (fig. 10). The support is made of two 2 by 4 inch pieces (AA), each 5 feet long and held 2 feet apart by two crosspieces (BB), of 2 by 4 inch stuff, nailed between and 1 foot each side of the center of the long pieces. Midway between the long pieces and fastened to the crosspieces is a 2 by 4 inch stick (C) through the center of which a $\frac{1}{2}$-inch hole is bored. To secure greater rigidity, a 2 by 4 inch stick (D) is mitered to fit from the center of one side to the center of one of the crosspieces. The reel is made of two pieces of 2 by 4 inch stuff (EE) 2 feet 9 inches long and mortised to the middle to form a cross. After these have been fitted together a $\frac{1}{2}$-inch hole is bored through the

center, and 9 inches from this center, on each arm, a ½-inch bolt (F) 10 inches long is set upright. A ½-inch bolt (G) dropped through the center of the reel and of the support completes the outfit. The cost of the whole apparatus is so small that it may be discarded, if necessary, when the work is completed.

No more wire should be strung out than can be put up and tied in during one day. Special care should be taken not to allow the wire to lie across trails or roads where it might be run over by vehicles or trampled by animals. Kinks or nicks made in this way may weaken the wire sufficiently to cause it to break as soon as a little strain is put upon it or when it contracts in cold weather. All kinks should be straightened before the wire is stretched. If the kinks or nicks are bad, they should be cut out and a splice made.

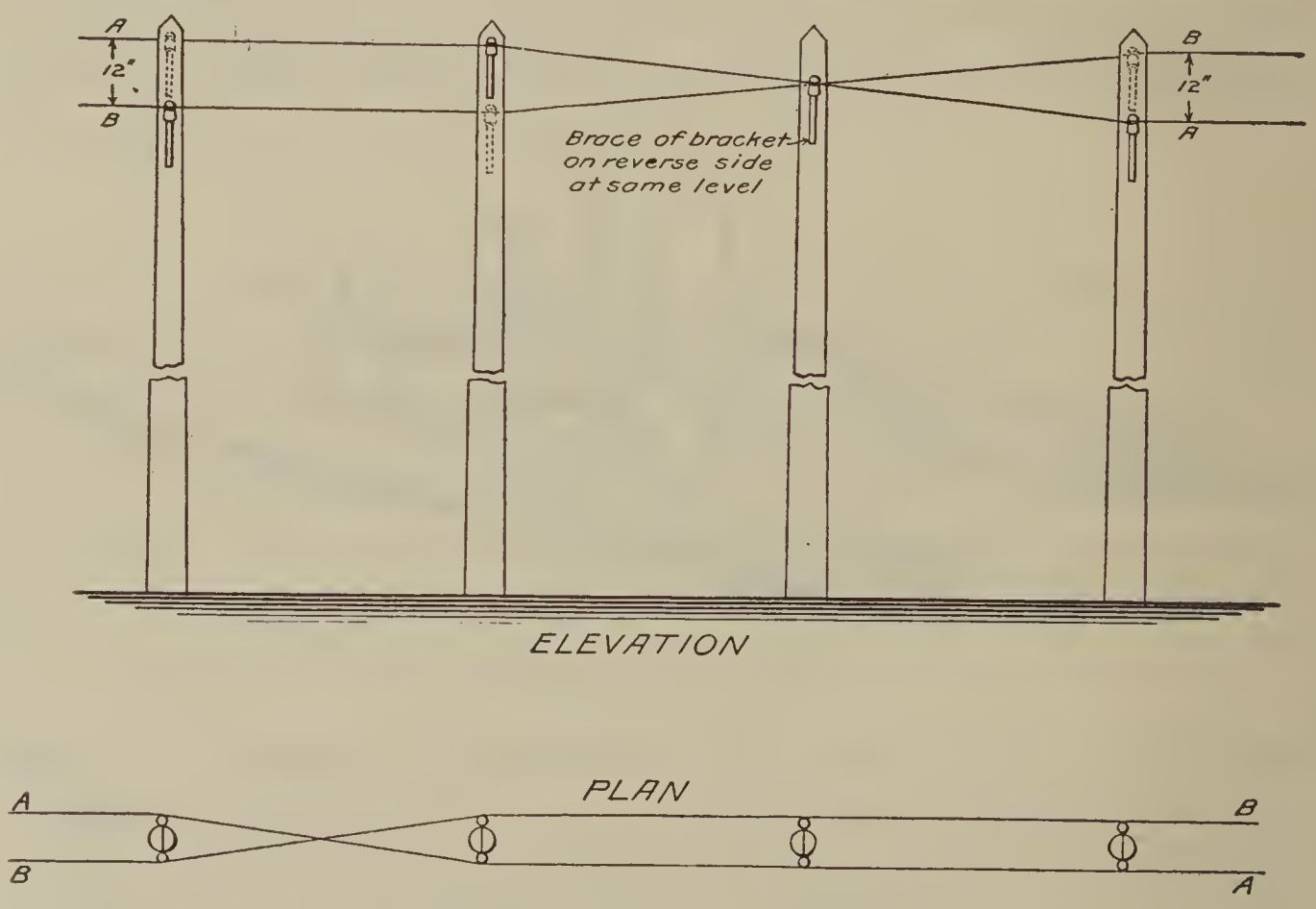


FIG. 11.—Transposition of wires (metallic circuit).

TRANSPOSING LINES.

By transposition is meant changing the location of a wire from one side of the pole to the other (fig. 11). This is done to overcome the effects of outside interference existing in lines which are close to or parallel with high-tension transmission lines and wires which are on poles carrying other wires.

When building a metallic circuit, the wires should be transposed once every mile. Where the line is exposed to induction, cross talk, power or electric-light wires they should be transposed at least every tenth pole. In transposing telephone lines, the wire on the left should

always cross over, never under, the wire on the right and without touching it. On a bracket line the transposition can be made very easily by changing the location of the brackets on the pole, as shown by the upper diagram in figure 11. When a cross arm is used, transpositions can best be made by using a standard two-piece transposition insulator. Transpositions should be arranged for at the time the wire is unreeled, the left-hand wire crossing over on top of the right at the point where the line is to be transposed.

SAG ALLOWANCE.

The stresses in the telephone wire undergo changes with variations in temperature, thus making it necessary to provide for the extreme variations in wire length in each span. The sag in the wire at the time it is made fast to the brackets should correspond to the temperature at that time.

TABLE 3.—*Sag of a No. 9 B. W. G. galvanized-iron wire in a pole line.*

(Temperatures in degrees Fahrenheit.)

Length of span (feet).	Sag at—											
	+100°.		+80°.		+60°.		+30°.		+10°.		−10°.		−30°.	
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
75		4½		3		2½		2		1½		1½		1
100		7		5½		4½		3½		3		2½		2
115		9		7		5½		4		3½		3		2½
130		11		8½		7		5½		4½		4		3½
150	1	2		11½		9		7		6		5		4½
176	1	6	1	3	1	0		9½		8		7		6
200	1	10½	1	7	1	4	1	0		10½		9		8
260	3	3½	2	10	2	5½	1	11	1	8	1	5½	1	3
300	4	7	4	1	3	6½	2	9	2	5½	2	1½	1	10
350	6	6	5	6	4	11	3	10	3	5	3	0	2	7
400	8	0	7	0	6	6	5	0	4	6½	4	½	3	7
450	10	0	9	0	8	0	6	6	6	0	5	6	5	0
500	12	6	11	0	9	6	8	0	7	6	7	0	6	0

NOTE.—If a strong wind is blowing, the sag value should be increased. Interpolate for temperatures and spans not given. When any size other than a No. 9 B. W. G. wire is used, it will be necessary to compute the sag required. Instructions for doing this will be furnished by the district office.

Sag may be handled in the following manner: After a half-mile reel of wire has been pulled out, linemen, who follow, carry the wire up each pole on their shoulders and place it between the bracket and the pole. When this has been done over the entire half mile, the line is stretched by means of a Buffalo grip and stretcher block until it is taut, or until the two or three linemen who are on the poles along the half mile stretch pass along the signal to stop. About two minutes' rest is then required for the line wire to "creep" along the entire distance. It should then be loosened or stretched tighter, according to the signals of the men on the poles, who can sight from the bracket of one pole to the brackets of the adjacent poles and determine when the proper amount of slack has been provided.

TYING IN WIRE.

On straight lines wires should be tied to the inside of the insulator, so as to bring it between the insulator and the pole. On curves and

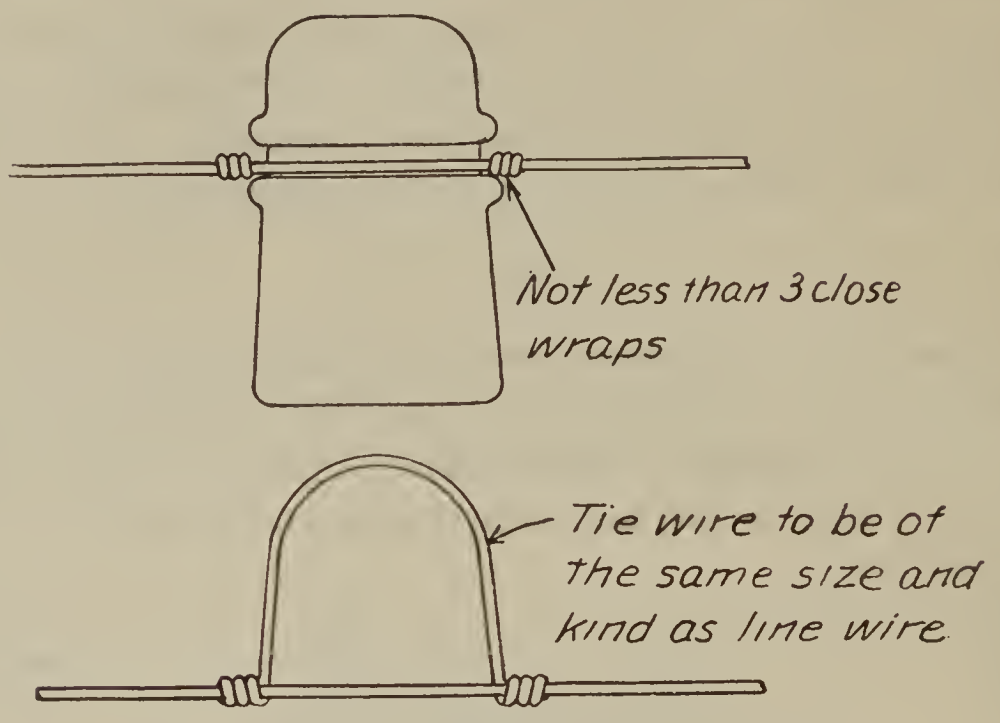


FIG. 12.—Method of making regular tie for iron wire.

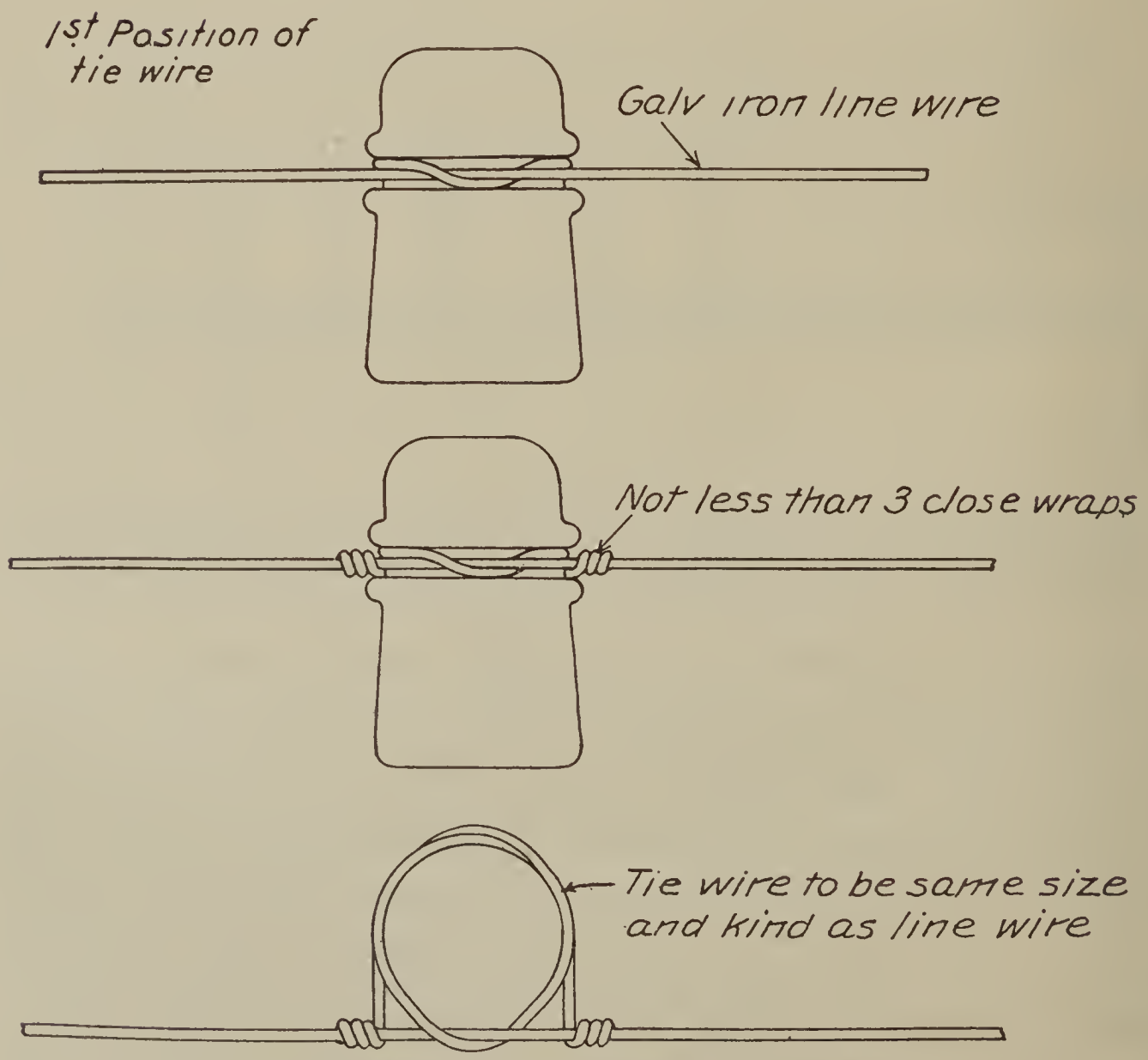


FIG. 13.—Method of making "figure 8" tie for iron wire.

corners the wire should be tied to the insulator on the outside, so that the strain will be against the bracket and the pole.

On pole-line construction the tie wire (the wire used to fasten the main line to the insulator) should be of the same size as the line wire. The method of tying wire to a glass insulator is shown in figure 12.

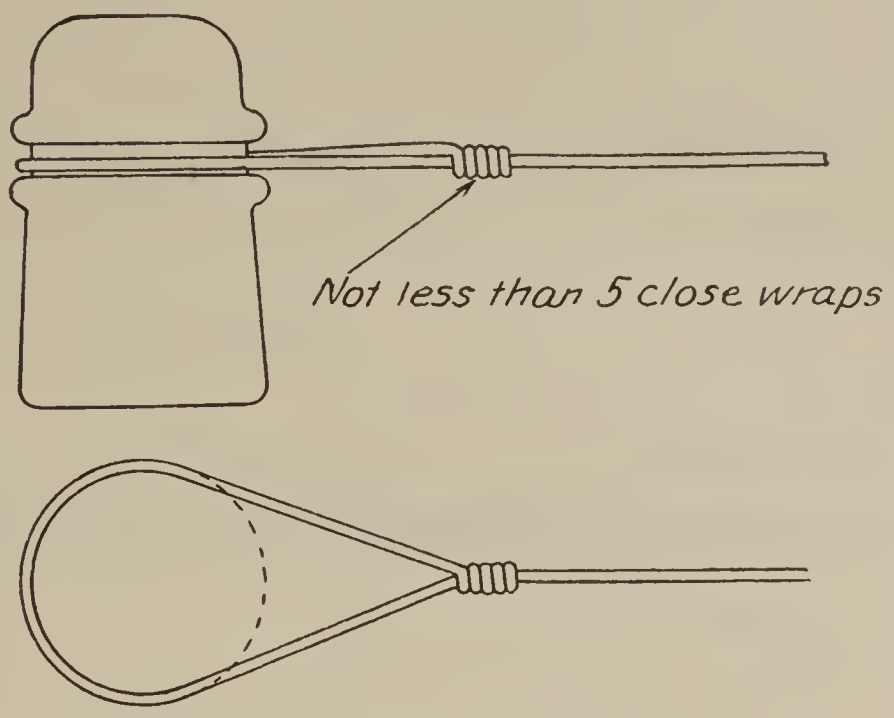


FIG. 14.—Method of dead-ending iron wire.

In making the tie great care should be exercised to avoid twisting the wire so tightly that the main line will be burned.

Linemen should be cautioned against nicking the line wire in making ties, especially when this is hard-drawn copper. The latter

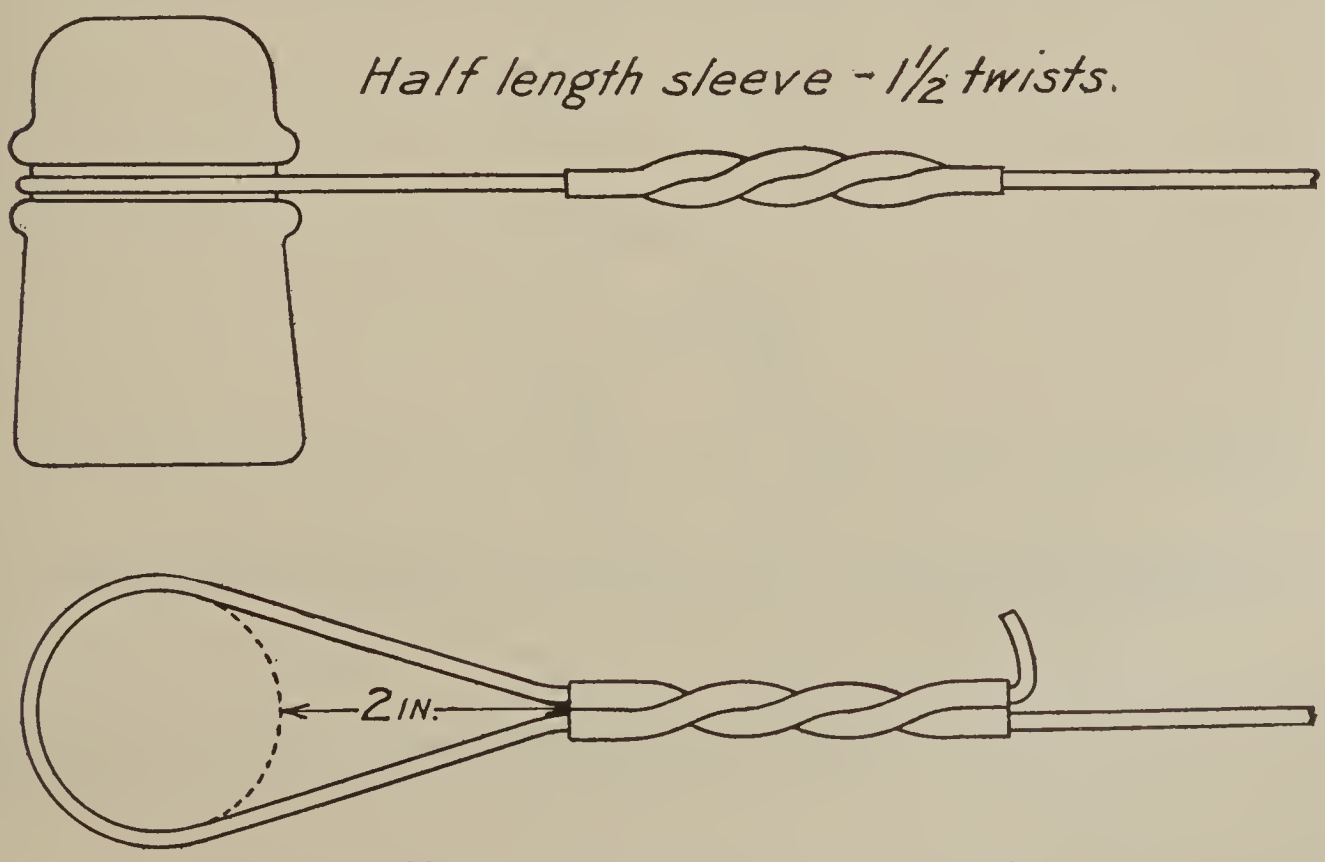


FIG. 15.—Method of dead-ending hard-drawn copper wire.

should always be tied by hand, pliers, connectors, or other tools being used only with iron wire. Linemen should also be cautioned against leaving the ends of the tie wire protruding, lest through twisting of the pole a contact be made.

Tying galvanized-iron wire.—There are two methods of tying galvanized-iron wire. The regular tie (fig. 12) should be used on all poles except where there are sharp dips or changes in level in the line wire, or in crossing railroad rights of way, or on spans from 250 to 500 feet, in which cases the "figure 8" should be used (fig. 13).

When the work of stringing wire on a pole line is stopped for a short time, or at the end of the day, the last tie put on will be a figure 8 tie. The line wire will then be continued over the bracket of the next

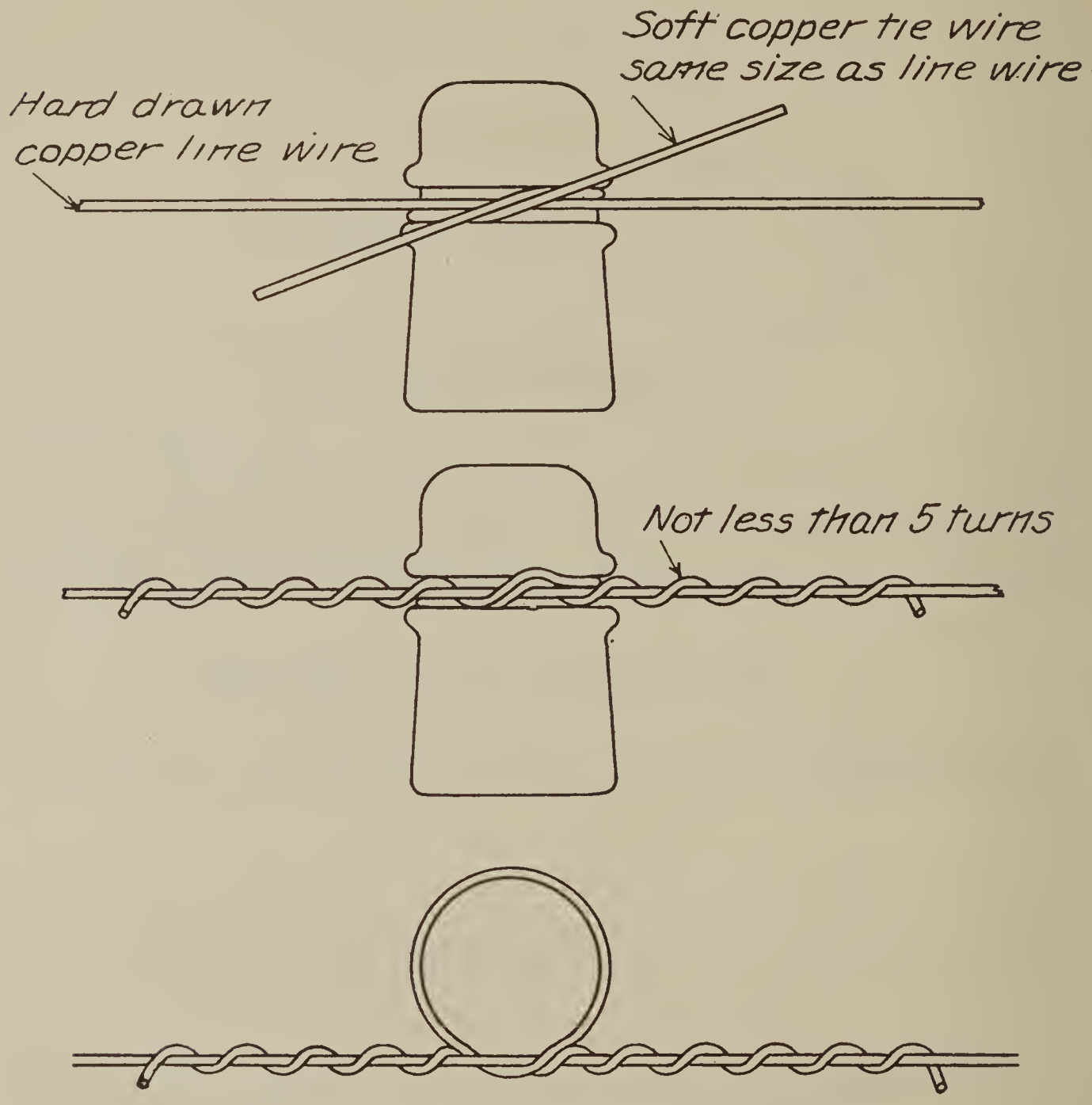


FIG. 16.—Method of making regular tie for hard-drawn copper wire.

pole without being tied, and brought down and anchored to the butt of the next farther pole by means of a Buffalo grip and either stretcher blocks or a snub.

The figure 8 tie is made by first bending the tie wire into a horseshoe shape just large enough to fit the insulator, putting it over the line wire (first position, fig. 13), which has been placed in the groove of the insulator, and then bringing the two ends of the tie wire around the insulator in opposite directions and wrapping them tightly around

the line with not less than three wraps, as close together and as tight as possible, using pliers or connectors for the purpose.

The line should be dead ended (fig. 14) at such places as the first and last pole of a main or branch line, or at a station.

Tying hard-drawn copper wire.—All tie wires for hard-drawn copper wire should be of the same size as the line, but of annealed (soft) copper. Soft tie wires may be purchased in bundles, or they can be made by cutting up the line wire and heating and then cooling it slowly to make it less brittle. Care should be taken not to heat the wire too hot, so that it pits, or to cool it too quickly. Hard-drawn

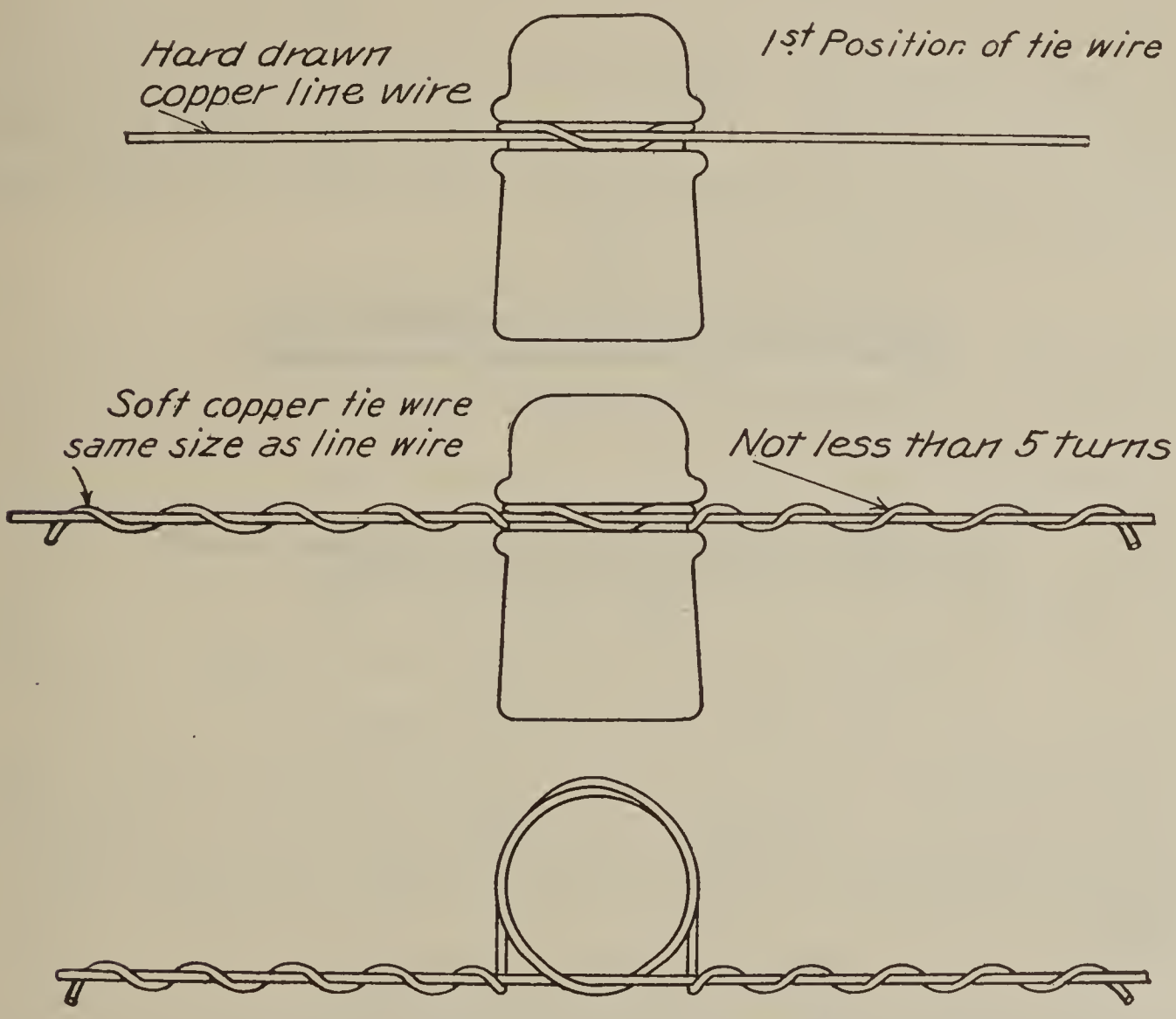


FIG. 17.—Method of making "figure 8" tie for hard-drawn copper wire.

copper wire is dead ended (fig. 15) by the use of a half-length double-tube copper sleeve.

The regular tie for copper wire (fig. 16) should be used in all cases except where a figure 8 tie is required (fig. 17).

SPLICING WIRE.

The standard Western Union joint (fig. 18) or the standard three-wire splice should be used for uniting galvanized-iron wire, and the standard double-tube copper sleeve for hard-drawn copper wire (fig. 19); galvanized-iron sleeves should not be used. Copper sleeves should not be used for splicing galvanized-iron wire, because the

resulting corrosion of the latter results ultimately in a high-resistance joint which may become the equivalent, from an electrical standpoint, of several miles of extra line.

When copper sleeves are used for joining hard-drawn copper wire, they should be twisted not less than three nor more than four turns

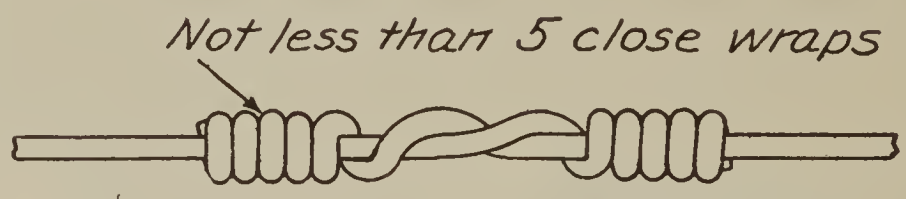


FIG. 18.—Method of splicing iron wire (Western Union joint).

with a pair of reversible connectors of the No. 309 type. The ends of the wire should project approximately 1 inch from the end of the sleeve before twisting. After the sleeve is twisted the protruding ends of the wire should be cut off not closer than one-fourth inch and bent back slightly on the sleeve.

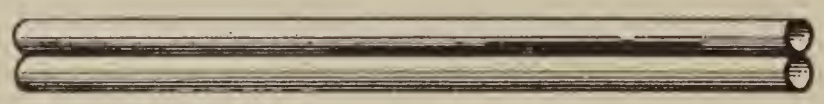


FIG. 19.—Method of splicing hard-drawn copper wire.

In ordering sleeves it is necessary to specify the size of the wire for which the sleeve is required. In making joints every precaution should be taken not to nick the wire, whether galvanized iron or copper.

TREE-LINE CONSTRUCTION.

With a telephone line passing through a heavy stand of timber, the possibility of trees falling across the line makes it essential that the line wire should be able to give way without breaking. The rigidity of the standard pole-line construction is therefore undesirable.

The tree-line method is generally used when poles are scarce or inaccessible, when ground conditions are unsuitable to the setting and maintenance of poles, or where there is not enough money available for the construction and maintenance of a standard-pole line.

The essential features of the tree-line method are the use of the split insulator and a suspending wire support. The former allows the line wire to draw through it when there is a pull from one side; the latter permits the wire to be attached to the tree itself.

Metallic-circuit tree lines are seldom used. Short circuits, resulting from broken wire ties and from trees falling across the lines, make this method of construction impracticable under ordinary conditions. Where the danger from high-voltage transmission lines is great and other conditions make the use of a tree line desirable, the wires should be strung on separate trees and the standard methods of transposition followed.

For successful tree-line construction, the following six rules should be kept constantly in mind:

1. Slack wire.
2. Equalized spans.
3. Weak ties.
4. Standard installations.
5. No sharp turns in line.
6. Avoid attaching wire too high on trees.

SELECTING TREES AND ROUTE.

Judgment and care should be used in selecting the trees to support the line, and also in determining the tying place on each tree and the method of tying. Only sound trees should be selected, of sufficient diameter to minimize the swaying, but large and smooth trees that are difficult to climb should be avoided. The course of the line should be varied to take advantage of trees that will lessen the cost of construction; but if suitable trees are not available, poles should be used.

In tree lines the spans should not exceed 175 feet. If possible the average span should approximate 100 feet, and may be shorter if necessary. The spans should be equalized.

The crooks and turns of the trail should not be followed unless to do so would mean more economical and better construction. The line wire should never touch the trunk of a tree, and care should be taken when attaching the insulators to see that the pull of the wire is away from the tree and not against it. On side hill slopes the line will be strung, if practicable, below the trail, so that in case the wire comes down it will not fall on the trail. Wherever possible avoid crossing the trail.

LINE CONSTRUCTION.

STRINGING WIRE.

The methods given on page 28 are also applicable to tree-line construction, although the latter offers less opportunity for the use of a wagon. The same precaution should be taken not to injure the wire.

A large amount of slack should be provided. The exact amount will be determined by the conditions, topography, etc., but in general each span should be given about 4 feet. The aim is to provide enough slack so that several trees may fall across a few spans without breaking the main line.

Under ordinary conditions the use of brackets in tree-line construction should be avoided.

HEIGHT OF WIRE.

The wire should not be hung at a greater height than on a pole line, and in general should be about 15 to 18 feet above the ground.

SPLIT-TREE INSULATOR ATTACHMENT.

The method of making the split-tree insulator attachment is shown in figure 20. C and D are the insulator attachments that have given the best results. The former uses No. 12 wire and comes loose from the staple whenever a tree falls across the line. In such cases neither the tie wire itself nor the split insulator breaks. To make repairs it is merely necessary to replace the attachment on the staple as illustrated in the figure.

The attachment D involves the same principle, but uses No. 9 wire. When this is employed it is necessary to keep only one kind of wire in stock, though the tie C is the least expensive. E shows a little stronger attachment made of No. 12 wire which should be used in conjunction with the crosstie shown by A. All ties should be attached to the tree by means of a 3 or 4 inch staple,[1] according to the thickness of the bark, about 1 inch of the staple being left protruding from the tree. A $2\frac{1}{2}$-inch post staple may be used in hardwood timber.

DEAD END OR CROSSTIE.

Figure 20 illustrates a complete crosstie with a No. 9 wire running through the insulator. Such a tie should be used wherever it is desired to prevent the wire from running back after breakage of the main line. It should be made of No. 12 wire, and be from 20 to 25 inches long. This tie is usually preferable to the insulator and bracket dead end, in that it lessens the chance of the main line being jerked by heavy winds.

The line should be stayed at the top of hills or the beginning of steep slopes. It is not necessary to stay it on comparatively even ground.

SPECIAL TYPE OF CONSTRUCTION.

In regions where there is little timber and practically no danger from windfall a No. $3\frac{1}{2}$ porcelain knob fastened to the tree with a 60-penny spike may be found satisfactory. It should not be used,

[1] When there is a possibility that the tree to which the insulator is attached may be cut into saw logs, a wire wrapped around the tree with a loop twisted in the middle should be used instead of the staple.

however, without the permission of the district forester. In this type of construction the spans should average about 100 feet, with from 10 to 15 feet of sag, according to the length of the span. A No. 12 wire should be used to tie the main line to the insulator, using the tie indicated in figure 16.

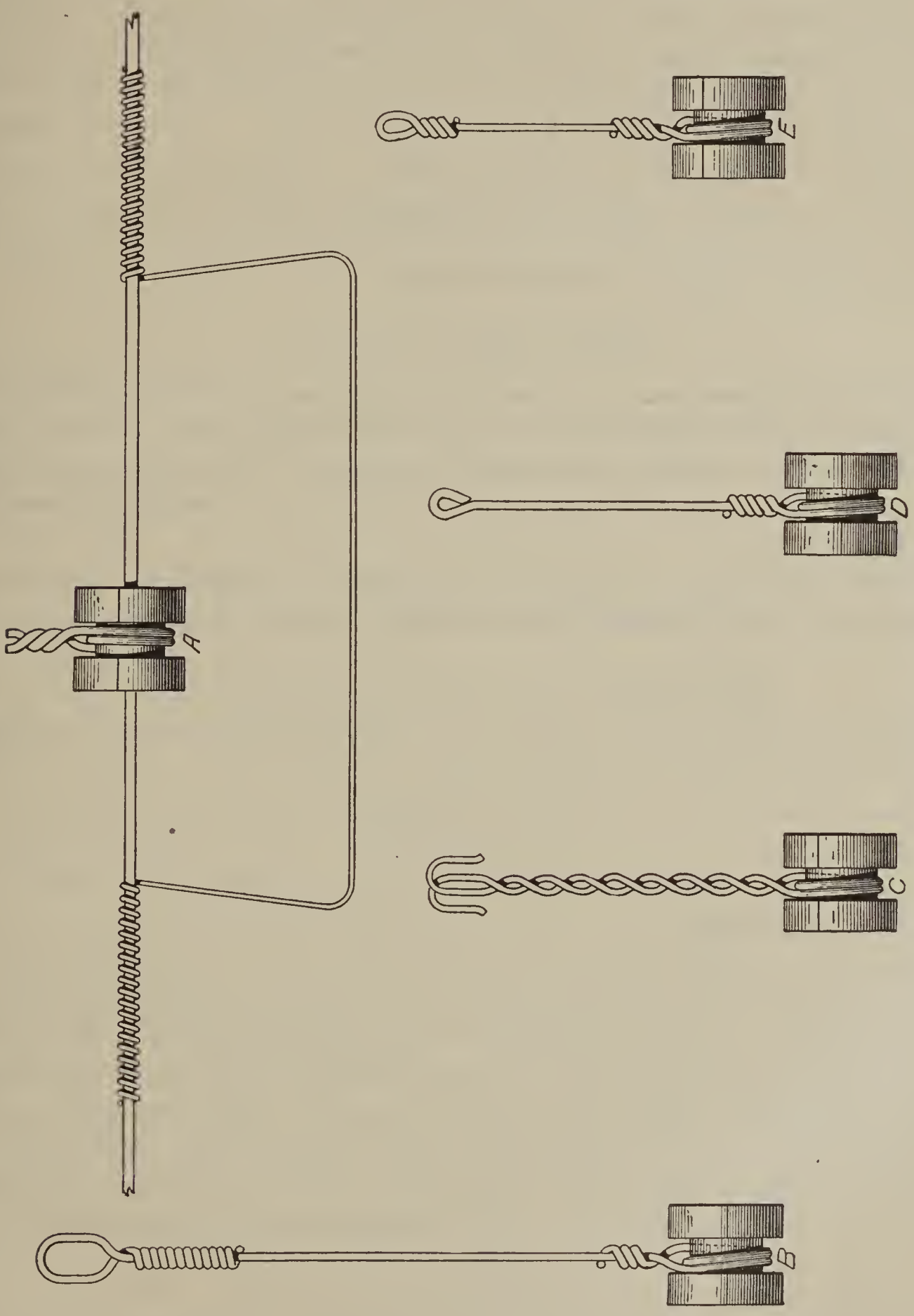


FIG. 20.—Split insulator attachment and crosstie.

The spike should be driven into the tree for almost its entire length, leaving only about $1\frac{1}{2}$ inches exposed. Since the weight of the wire falls on the top of the insulator, the strain on the tie wire is small. The lower branches of the tree should not be trimmed, since they tend to prevent the line from grounding when a tree falls on it.

CROSSING MEADOWS AND PARKS.

It may sometimes be preferable to cross small meadows and parks instead of making the detour necessary to the continued use of trees. Poles should ordinarily be used to make crossings of this kind.

When not more than six or seven poles are necessary, they should be considered as trees, and the line wire attached to each by a split insulator, allowing as much slack as elsewhere in the line. In this way no injury to the portion of the line in the park or meadow will be caused by a tree falling on an adjoining span. If a large number of poles are required, the first four poles on each side of the meadow should be equipped with split insulators. For the remaining distance the standard pole-line construction with the sag in the spans as indicated in Table 3, should be used.

CROSSING RIVERS AND CANYONS.

Where it is necessary to cross a river or canyon less than 500 feet in width, a pole should be set (do not use a topped tree) on each side of the canyon or river and securely anchored. Each pole should be equipped with double brackets and the wire tied to the insulators with the figure 8 tie.

Where the span exceeds 500 feet, specific instructions should be obtained from the district forester before construction is begun.

CROSSING DIVIDES AND BUILDING TO LOOKOUT POINTS.

Two methods may be followed in constructing lines across divides and watersheds and to lookout points.

The usual tree-line construction should be used when the timber is heavy and such construction practicable. The line should follow a trail or road. Frequent switchbacks may be necessary in order to get over the divide.

The line should be hung on split tree insulators, using the regular attachment C, figure 20, except on trees at very abrupt changes in line direction. At such points a tie wire similar to B or E, figure 20, should be used, the tie being made of single No. 12 B. W. G. Best-Best galvanized wire. This tie is lighter than the main line and a trifle stronger than the ordinary ties (C and D, fig. 20), and will break as soon as more than one tree falls across the line, thereby providing all of the slack between the tree at the turn and the adjacent trees.

The second method will be followed when trees are scarce or when the other method of construction is not practicable. The line should be run straight up the side of the mountain. Brackets and glass insulators should be used, and the wire tied to the outside of the insulator with No. 14 B. W. G. Best-Best galvanized-iron wire, which is very light and will break easily. About 4 feet of slack should usually be allowed for a 100-foot span.

LOCATION ON POLES OF FOREIGN LINES.

When a Forest Service line is attached to a pole carrying a telegraph circuit, the former should be located at least 2 feet from the nearest telegraph wire. This same clearance should be maintained from any other non-Forest Service wire on the same pole. Forest Service lines should not be attached to poles carrying electric-light, power, or high-tension transmission lines. A grounded line should never be strung on poles carrying telegraph circuits. Use a metallic line.

CROSSINGS.

RAILROAD RIGHTS OF WAY.

Railroad rights of way should be crossed at right angles. Under no circumstances should a pole be closer than 15 feet to the nearest rail, and if it will not cause too long a span the distance should be sufficient to prevent the pole reaching the rail should it fall toward the track. The poles on each side of the track should always be guyed or braced three ways and it may be necessary to guy or brace them four ways.

The lowest wire at such a crossing should be at least 27 feet above the top of the rails, or even higher if required by State law or by the railroad company. The pole on each side of the right of way should be equipped with double brackets or double cross arms and the wire tied to the insulators with a figure 8 tie. If necessary, the method prescribed for underground crossings of high-tension transmission lines (page 42) will be used.

FOREIGN LINES.

Whether to cross over or under foreign lines will be determined by the character of their construction. If the foreign lines are well constructed and well maintained, they should be crossed underneath, at a distance of not less than 4 feet below their lowest wire, unless this would bring the Service line too close to the ground. In that case a crossing should be made over the foreign line, with a distance of not less than 4 feet between the lowest part of the telephone line and the highest wire of the foreign line. If the construction or maintenance of the foreign line is poor, the Forest Service line should in every case pass overhead.

ROADS.

If the line follows a road, crossing from one side to the other, the crossing poles should be braced or guyed, and a figure 8 tie used. The wire should be strung at least 16 feet above the road, or even higher if required by State law.

CROSSINGS OVER 500 FEET IN LENGTH.

Crossings more than 500 feet in length may involve the use of steel wire, special-strain insulators, towers, or bridge work, and special "A" or "H" construction. Before any construction is undertaken, the district forester should be asked to prepare proper specifications.

HIGH-TENSION TRANSMISSION LINES.

Contact at any point between a telephone line and a high-tension transmission line endangers both the entire telephone system and the lives of those who use it. In all cases when a high-tension transmission line is to be crossed by a Service telephone line, directions should be obtained from the district forester. Transmission lines should be given as wide a berth as possible. If it is necessary to run close to one, pole-line construction should be used.

Transmission lines should always be crossed at a right angle. Unless the district forester specifies otherwise or unless the transmission company has provided special and safe protection, the crossing will be made as follows: Dead end the telephone line on each side of the transmission line, at least 150 feet from the crossing, and brace or guy the last poles. The actual crossing should be made underground by means of an extra heavily insulated, rubber-covered, braided, and weatherproofed copper wire run through a $1\frac{1}{2}$-inch iron pipe, starting at a point on the pole about 6 feet above the ground. The joints in the pipe should be made water-tight by the use of red lead, and an inverted "U" attached to the top of each pipe so that rain water can not follow the wire. The rubber-covered wire should extend up the pole and be connected to the line wire. In crossing with a metallic circuit both wires may be run in the same pipe.

If considerable blasting would be required to put the iron pipe underground, below the frost line, it may be laid across the surface of the rock, providing it is covered with an earth embankment to a depth of 2 or 3 feet.

If permission is requested for a high-tension transmission line to cross an existing Forest telephone line, the district forester will require that the transmission line be so constructed as to provide safe and approved protection for the Service line. Where the telephone line is exposed to voltage in excess of 5,000 volts the American Telephone & Telegraph Co.'s specification No. 3414 for overhead crossings of electric-light and power lines will be used as a basis for determining suitable protection.

CONNECTION OF FOREST SERVICE LINES WITH PRIVATE LINES OR EXCHANGES.

Whenever it is desirable to connect a Forest Service line with a private line or exchange, the district forester should first be fully

advised by letter as to what arrangements can be made for the connection, including a statement of the ability to obtain night, Sunday, or holiday service, if needed in emergencies. There should also be stated the length of the Forest Service line, and, in cases where it is desired to connect directly to another line, the length of such line; the character of its construction and maintenance; the size and kinds of wire used in the construction of both lines, and whether one or both are grounded or metallic circuits; the number of instruments on both lines and the ohm capacity of the instruments on the line with which connection is to be made. The district forester will decide the best method of handling the matter and making the connections. Every precaution should be taken to make sure that trouble originating beyond the Forest Service line will not interfere with it.

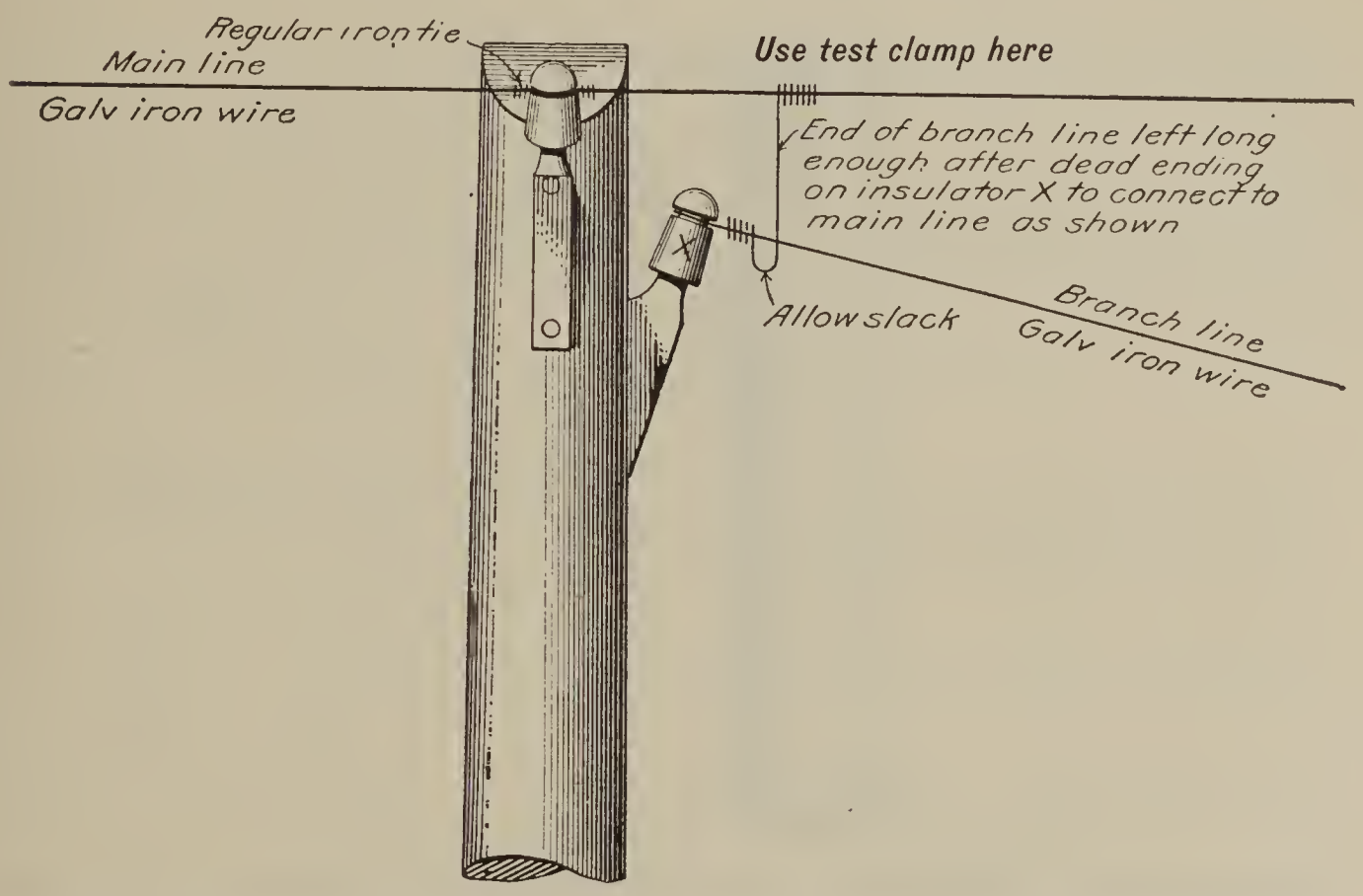


FIG. 21.—Method of connecting branch line to main line when both are of galvanized-iron wire.

BRANCH LINES.

In attaching a branch to a main line, the former should be dead ended on a separate bracket attached to the main line pole for that purpose, so that the strain of the branch line[1] will not come on the connection (fig. 21). A Fahnestock test clamp may be used to connect the branch line to the main line in place of wrapping the end of the branch to the latter.

When the main line is of hard-drawn copper wire, it should be cut in two and dead ended on the same insulator from both directions, splicing in additional wire if necessary. The ends after dead ending

[1] The Fahnestock test clamp is made in three grades: Entire clamp fully tinned, clamp half tinned, and untinned. The first type should be used for connecting two iron wires, the second for connecting a copper and an iron wire, and the third for connecting two copper wires.

should be left long enough to be spliced together in a copper sleeve so as to complete the circuit again. The branch line should then be dead ended on a separate bracket and insulator, and the connection made (fig. 22).

Whenever any wire is connected to a hard-drawn copper line, the latter must always be dead ended for that purpose, so that the wire may be soldered to a point on the dead-end loop between the sleeve and the insulator. When soldering is not feasible the wires should be cleaned bright, and the wire to be connected closely wrapped around the line wire not less than seven times. A Fahnestock clamp may be used here also.

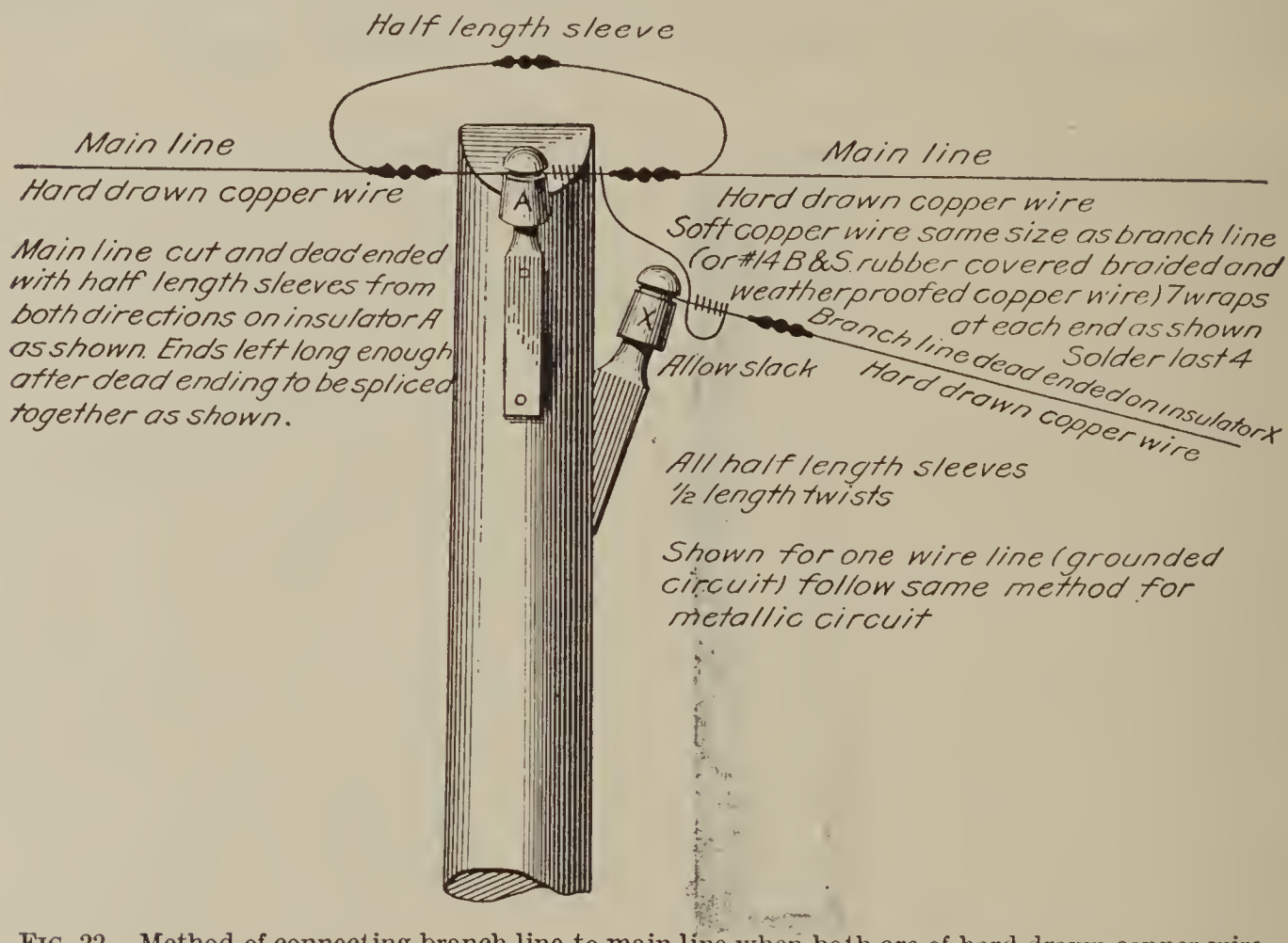


FIG. 22.—Method of connecting branch line to main line when both are of hard-drawn copper wire.

STANDARD TELEPHONE EQUIPMENT FOR FOREST SERVICE

INSTRUMENTS AND OTHER EQUIPMENT.

Telephone, wall set; type, Western Electric No. 1317–S, or equal; with 2,500-ohm unbiased ringer and condenser.

Telephone, wall set; type, Western Electric No. 1317–R, or equal; with 1,600-ohm unbiased ringer and condenser.

Extension bell; type, Western Electric No. 127–F, or equal; with 2,500-ohm unbiased ringer.

Extension bell; type, Western Electric No. 127–G, or equal; with 1,600-ohm unbiased ringer.

Telephone, lookout; type, Western Electric No. 1336–J, or equal; with 2,500-ohm unbiased ringer and condenser.

Telephone, lookout; type, Western Electric No. 1336–K, or equal; with 1,600-ohm unbiased ringer and condenser.

Telephone, Forest Service portable; special design for Forest Service work; No. 1375–A.

Switch and protector mounting box only; type, Western Electric D–400, or equal.

Protector; type, Western Electric No. 60–E, or equal.

Protector; type, Western Electric No. 58–F, or equal.

Line fuse; type, Western Electric No. 47–A, or equal; for line at stations when required.

Protector blocks; type, Western Electric No. 20 and No. 21, or equal; for repairing No. 60–E protector.

Protector block mica; type, Western Electric No. 10, or equal; for repairing No. 60–E protector.

Ground rod; type, Western Electric No. 94033 (or 52108), or equal; to have copper wire soldered to end.

Ground rod, Forest Service portable; special design for Forest Service work; No. 313–B.

Battery dry; type, Western Electric No. 100028 Blue Bell dry battery, or equal; for station telephones.

Battery dry, for Forest Service portable telephone. Columbia OV No. 3 or Ever Ready Tungsten No. 703.

Repeating coil; type, Western Electric No. 47–A, or equal; for special cases where a grounded line is connected to a metallic circuit.

Switch, single-pole single-throw porcelain-base knife switch; type, Western Electric No. 1436, or equal.

Line connector, Forest Service portable; special design for Forest Service work; 311–B.

Brackets.—Twelve-inch painted oak brackets, conforming to specification of the American Telephone and Telegraph Co.

Wire.—For ordinary use: Galvanized iron No. 9 B. B. For special use: Galvanized iron No. 12 and No. 14 B. B.; hard-drawn copper No. 8, No. 12, and No. 14; steel (as required). For emergency use: No. 20 stranded Brown & Sharpe gauge copper wire insulated. Conforming to specifications of American Telephone & Telegraph Co.

Insulators.—Line insulators of the type known to the trade as regular pony-distance type, weighing approximately 14 ounces each, conforming to specification of the American Telephone & Telegraph Co.

INSTRUMENTS.

Where a Forest Service line is to connect with another line, either directly or by switches, the resistance in ohms of the ringer coils in the instruments (and extension bells, if used) should be the same as the resistance of those in the connecting line. The standard resistance of all ringer coils on exclusive Forest Service lines will be

2,500 ohms. However, in connecting with lines that use other resistance ringer coils, it will be necessary to use the same resistance coil in the instruments on the Forest Service line. Where telephones of other resistance than that specified are needed for use, the district forester should be consulted as to the proper set to purchase.

The portable telephone was designed to meet the special needs and requirements of the Service. It is equipped with the standard bell transmitter and receiver, which makes possible transmission over great resistance. The battery should be replaced every two months.

INSTALLATION OF EQUIPMENT.

CONDENSER.

The condenser in a telephone is cut in circuit with the receiver. It makes possible "through" signaling when receivers at intermediate stations are off the hooks. Any telephone now in use, if not already provided, can be equipped with a condenser.

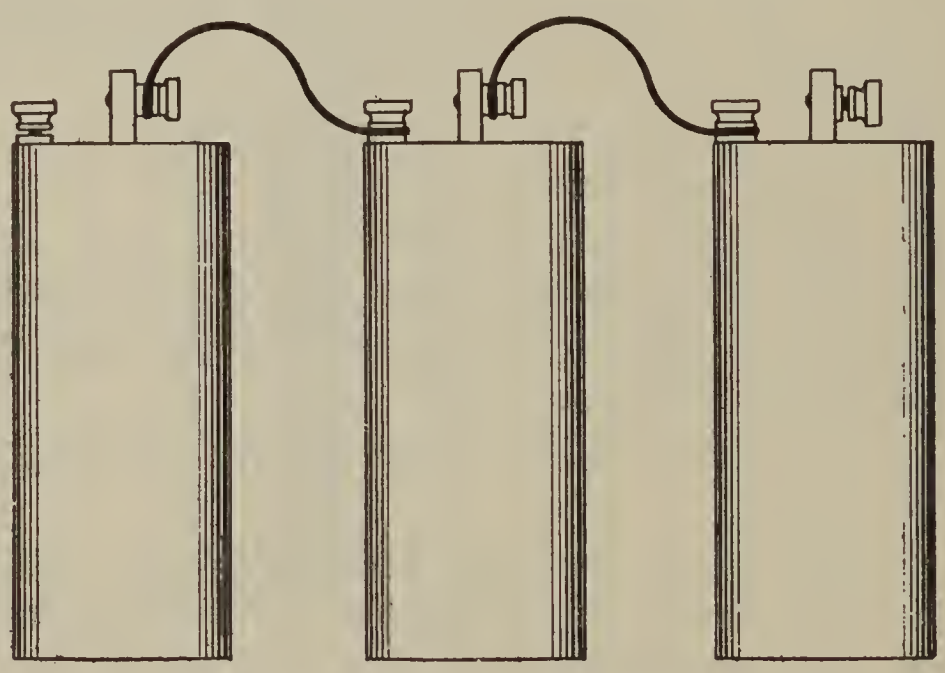


FIG. 23.—Method of connecting dry batteries for a telephone.

The condenser may also be cut in on one side of the ringers for testing purposes.

DRY BATTERIES.

Three dry batteries should be placed in each instrument, taking care that the connections are made as shown in figure 23. Dry cells deteriorate whether used or not, and it is necessary to replace the set in each instrument at least once a year.[1] Standard flexible battery connectors will give better results than a one-strand wire, which breaks easily when nicked.

[1] Two new batteries should never be installed with one old battery or one new battery with two old batteries, as one poor battery will spoil the efficiency of the good ones.

PROTECTION.

The question of protection is a very important matter and is divided into two classes in Forest Service work: (1) partially exposed substations and (2) fully exposed substations.

PARTIALLY EXPOSED SUBSTATIONS.

Where it is absolutely certain that the line is nowhere exposed to accidental contact with electric-light, power, or high-tension cir-

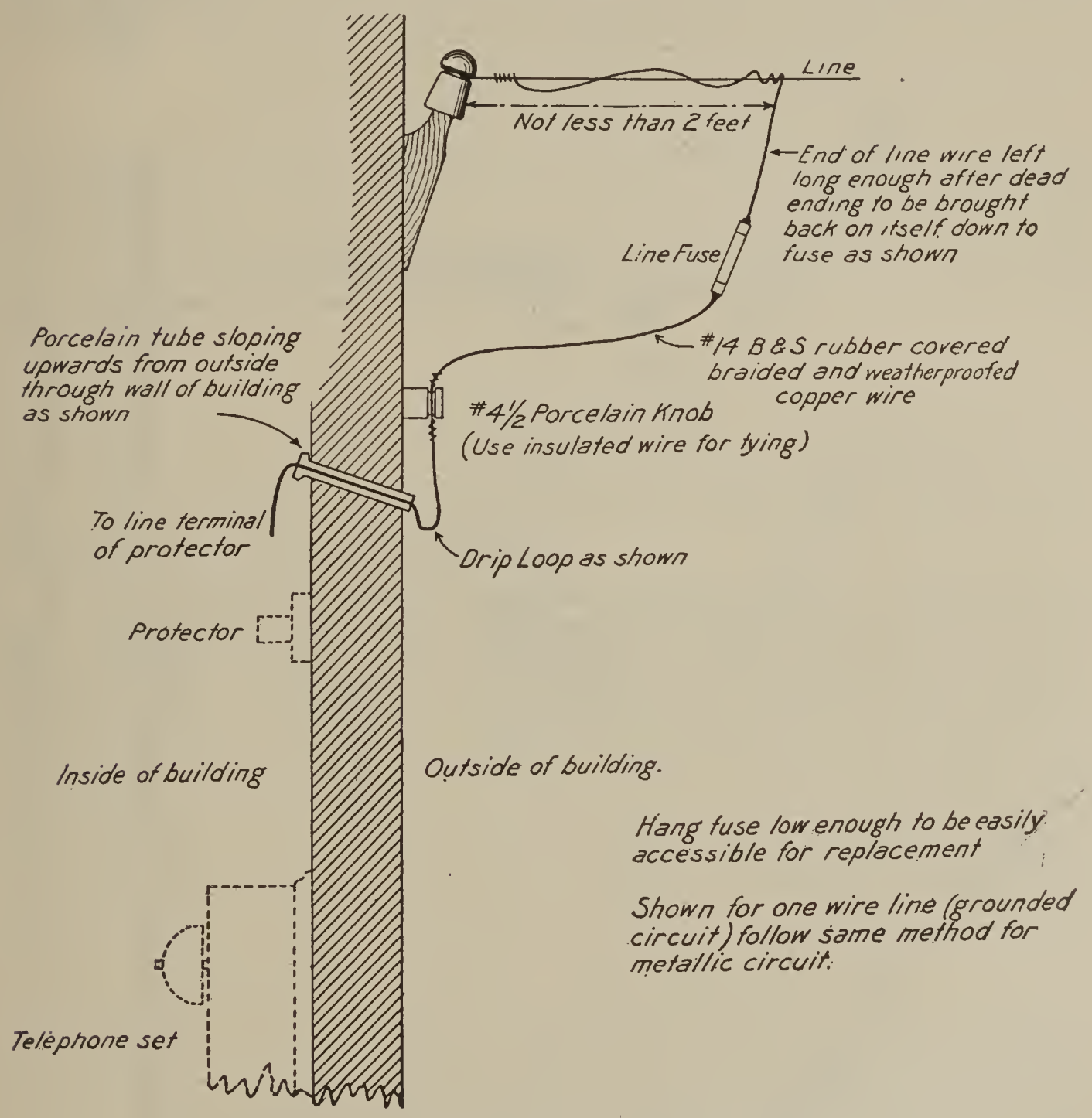


FIG. 24.—Method of installing line fuse when required.

cuits (but only to lightning), each telephone station should be considered as partially exposed, and nothing beyond the No. 60–E protector used for protection. Where lightning is unusually severe, however, either a 47–A line fuse, in addition to the 60–E protector, or a 58–F lightning protector should be used. The former should be located immediately outside of the building and attached to the main-line wire in such a way that, when blown, the wire on the side toward the line will fall away (fig. 24). On a metallic line, where line fuses

are used, a fuse should be attached to each wire. When the 58–F, which is a combination of the 60–E protector with fuses, is used, a

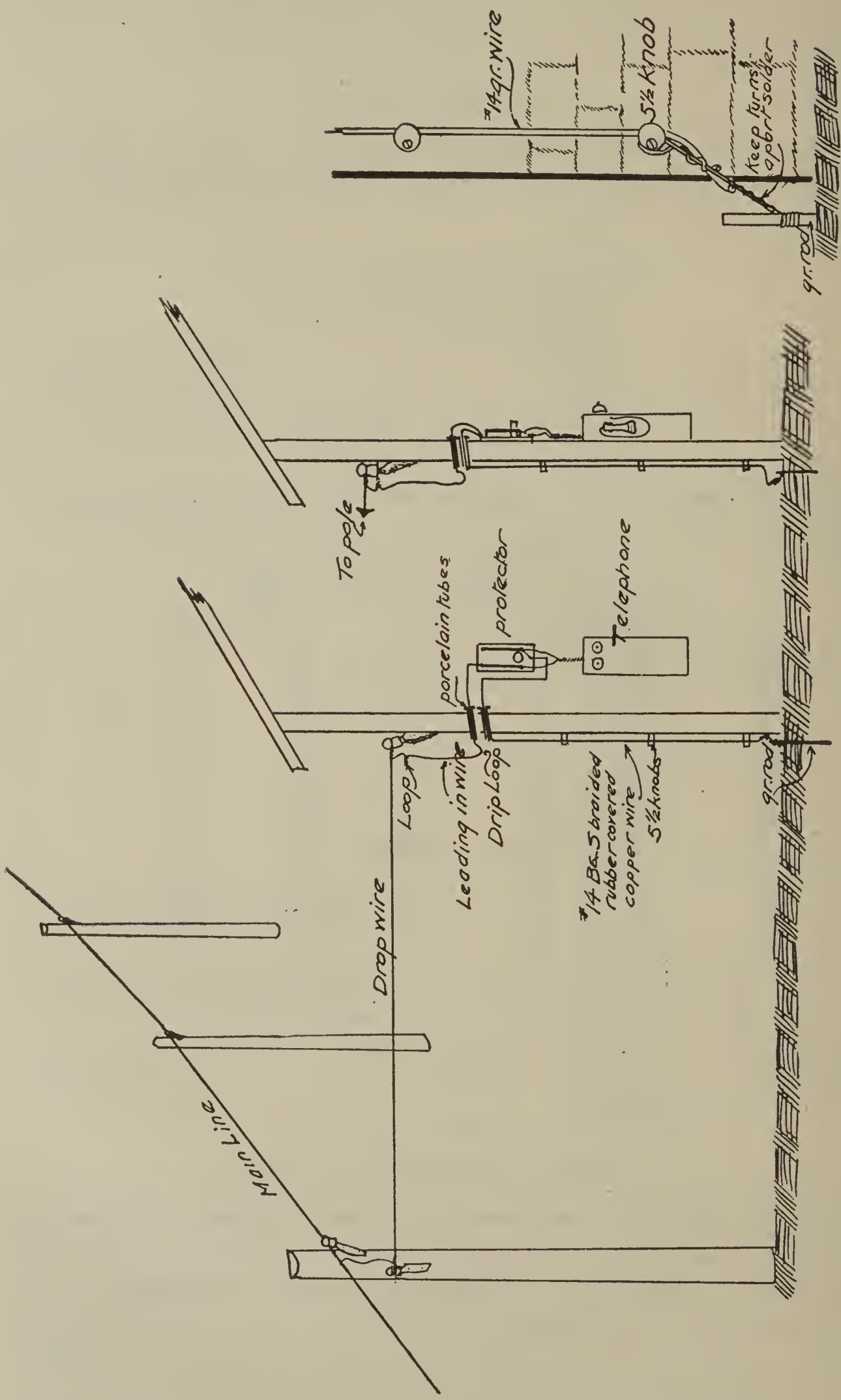


Fig. 25.—Leading in wires and connections to phone.

No. 48 asbestos mat should be mounted back of all protectors and the slits in the fuses turned toward the mat.

FULLY EXPOSED SUBSTATIONS.

A fully exposed substation is one on a line which may be exposed to accidental contact with electric-light, power, or high-tension transmission lines. Even though only a portion of the line is subject to such exposure all stations on it will be considered as fully exposed. The 60–E protector and 47–A line fuse, or the 58–F protector, will be used at these stations. In all cases where the line is exposed to a high-tension voltage in excess of 1,800 volts the district forester should be consulted in regard to additional protection.

CONNECTIONS WITH FOREIGN TELEPHONE LINES.

In general, it is not necessary to consider the exposure along other telephone lines with which the Service lines may connect, provided the connection is made through a switchboard. If made by any other means, however, one of the above-described protective methods will be used.

GROUND RODS.

All grounded lines should be provided with a good electrical connection to the ground for the earth return side of the telephone circuit. One of the great sources of trouble in this type of construction results from a poor ground.

The ground rod should be of galvanized iron, 5 feet [1] long and one-half inch in diameter, with a copper wire securely soldered to the top. The rod should be driven to full depth into a permanently damp or moist earth soil, and as close to the building and to the instrument as practicable. If it is impossible to drive the rod vertically to its full depth it should be driven on a slant, for it is essential that the moist earth come in contact with the full length of the rod. When necessary the ground may be located several hundred feet from the instrument, in which case the wire from the building to the rod should be buried under the sod.

Dry earth, gravel, and rock are not good conductors and should be avoided. A rod driven into the bank of a creek or spring may provide a satisfactory ground. When there is no naturally moist soil a good ground may be obtained by placing a 25-foot coil of No. 9 wire at the bottom of a 6 to 10 foot hole, covering it well with charcoal and wetting the latter with a bucket of water. The hole should then be refilled and the earth tamped in securely. Charcoal is hygroscopic, and will absorb and retain moisture. The connection of the ground wire with the coil should be soldered. A bucket of water thrown on the ground at intervals during a dry period will add to its effectiveness.

---

[1] Six-foot rods of the same type may be used if necessary.

A satisfactory ground can not be obtained by attaching a wire to a bunch of old iron and throwing it into a river or creek with a rocky bottom. In some buildings it is possible to use a water pipe for a ground, in which case the ground wire should be attached to the pipe by a Blackburn ground clamp. Only pipes which always contain water should be used.

LAVITE COILS.

These coils are used to remove static electricity from the line. Each coil should have a resistance of 48,000 ohms, and be inclosed in a small weatherproof box. (See p. 66, Static electricity.)

WIRING.

To insure good service instruments on both grounded and metallic lines must be installed in the proper manner. Figures 25 and 26 illustrate graphically the method of making the entire installation.

Before beginning work means should be taken to determine the arrangement that will be the simplest, most economical, and the easiest to maintain.

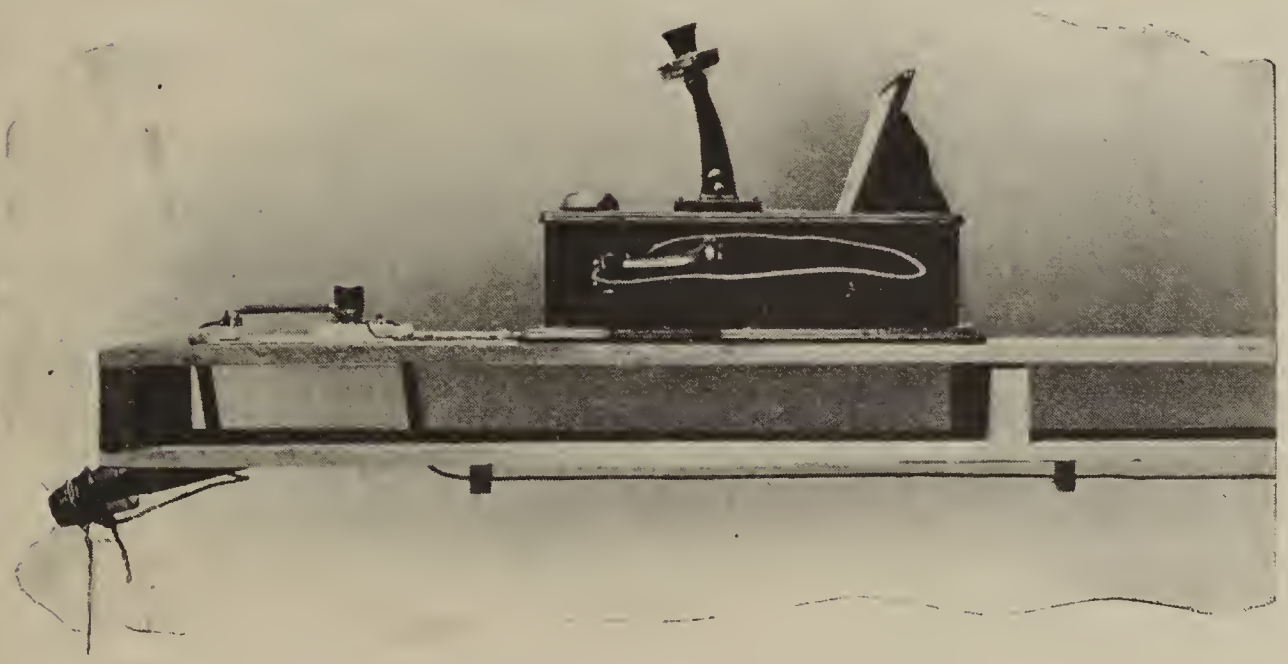
OUTSIDE OF BUILDING.

Leading-in wires.—If possible, the telephone should be located on the same side of the building as the pole from which the branch line originates. The wire from the line should be dead ended on a bracket and insulator attached to the outside of the building. The point where the wire enters the building should be as near as practicable to a permanent ground, and each ground wire should pass through the wall of the building in a separate porcelain tube, spaced at least $2\frac{1}{2}$ inches from the other tubes, and sloping upward from the outside. Under some conditions circular loom may be a satisfactory substitute for the porcelain tube, though it should not be used without permission from the district forester. Each wire as it enters the porcelain tube outside the building should have a small drip loop about 2 inches long to prevent water from following it into the building. The location of the protector in the building should be determined before the holes are made. It is often possible to locate the holes immediately above or below the fuse terminals on the protector, thus securing the shortest length for the leading-in wires.

The leading-in wires should not enter at the attic roof unless other ways are impracticable. In every case the holes should be started from inside the building.

The line terminals of the protector should be connected to the line wire by single No. 14 B. & S.[1] braided and weatherproofed rubber-covered copper wire. The leading-in wire should be soldered to the loop just below the insulator where the line wire is terminated (fig. 26), and should not come in contact with any part of the building.

[1] Brown & Sharpe (gauge).



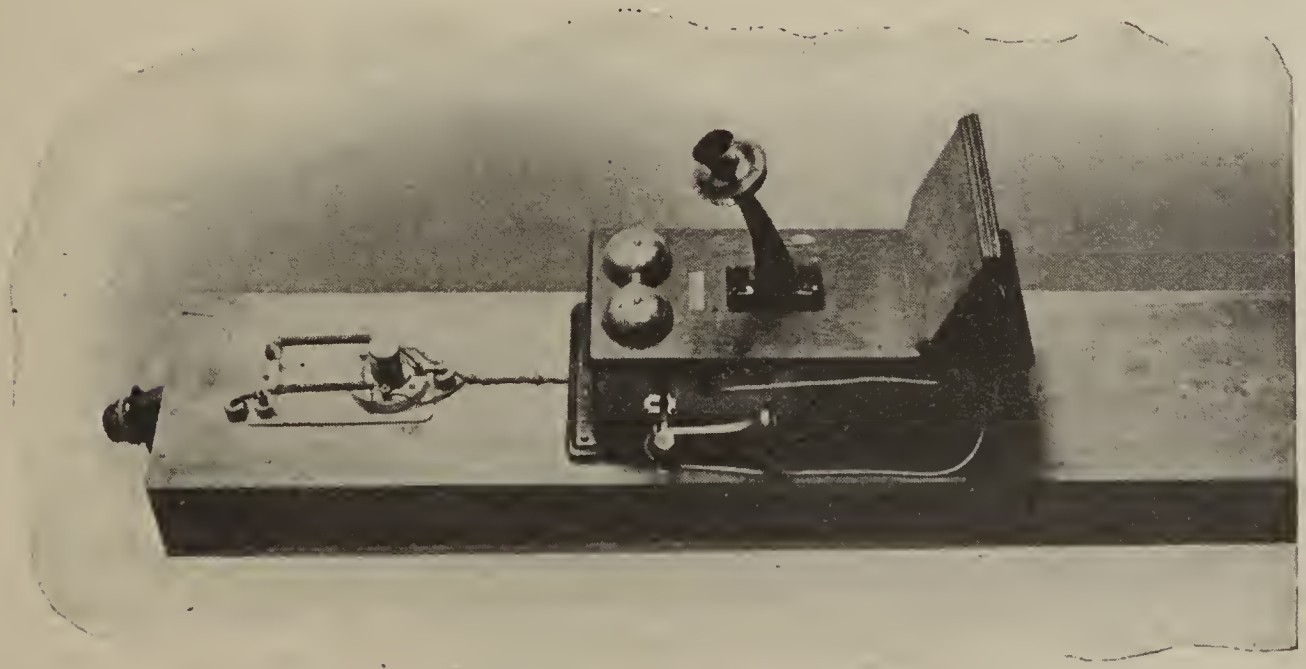


FIG. 26.—Standard telephone installation.

Ground wires.—Single No. 14 B. & S. rubber-covered, braided, and weatherproofed copper wire should be used to connect the protectors with the ground rod or ground wire.

Ground wire outside of the building should be supported on No. 4½ or No. 5½ porcelain knobs. The knob should always be attached with a flathead screw, and not with a nail.

The wire from the protector to the ground should be laid as directly as possible, and should have no spirals, coils, knots, or sharp bends. The ground wire should never be placed near sheet-iron roofing, drain pipes, etc., on the house.

INSIDE OF BUILDING.

All joints and splices of the wiring inside or outside of the building should be taped. This does not apply to the connections made at the terminals provided in the apparatus. All joints should be soldered and properly taped. Where a twisted pair is spliced, the joints should be soldered at least 3 inches apart. In soldering, resin should be used as a flux. Chlorid of zinc, sal ammoniac, or other fluid fluxes are not satisfactory. The wires to be soldered should first be scraped thoroughly and cleaned.

All knob and cleat work should be done as neatly as possible. Wiring inside and outside of a building should be run in as nearly vertical and horizontal lines as possible; this gives an appearance of neatness and simplifies tracing out the wires when hunting for trouble. There should be no knots or spirals in the wiring (this does not mean joints and splices) between the protector and the line or ground rod. The line should be kept at least 1 foot away from the overhanging eaves if the roof is of sheet iron. Wet and damp localities should be avoided for inside wires.

The telephone should be connected to the protector by means of No. 19 B. & S. rubber-covered and braided single or twisted pair copper wire. However, if this wire is not available, the heavier insulated outside wire may be used, although it is not so cheap. The wire inside the building should be fastened to the wall with insulated tacks (such as milonite nails) or approved cleats. Uninsulated tacks or staples should not be used. No joint in insulated wire should touch an adjacent joint in another insulated wire, even though both are taped.

Location of protector.—The protector should be placed inside the building (never outside) as near as possible to the point where the leading-in wires enter. When the 58–F type is used, a No. 48 asbestos mat will be placed on the wall beneath it. This protector should be mounted upon the wall so that the fuses are vertical, and fastened in place by screws. It should not be exposed to water or dampness. When the leading-in wires enter the building above a door or window casing, the protector should be mounted so as to allow a space of 1

inch between the protector and the casing. Where the wires enter at the side of the door or casing, the protector should be mounted flush with the latter. It should always be placed at least 6 inches from curtains, shades, or similar combustible material.

Ordinarily only one mica should be used between each pair of protector blocks, but in localities where lightning is excessive and the stations difficult of access, two micas may be inserted, thus increasing the air gap. Paper or other material should never be substituted.

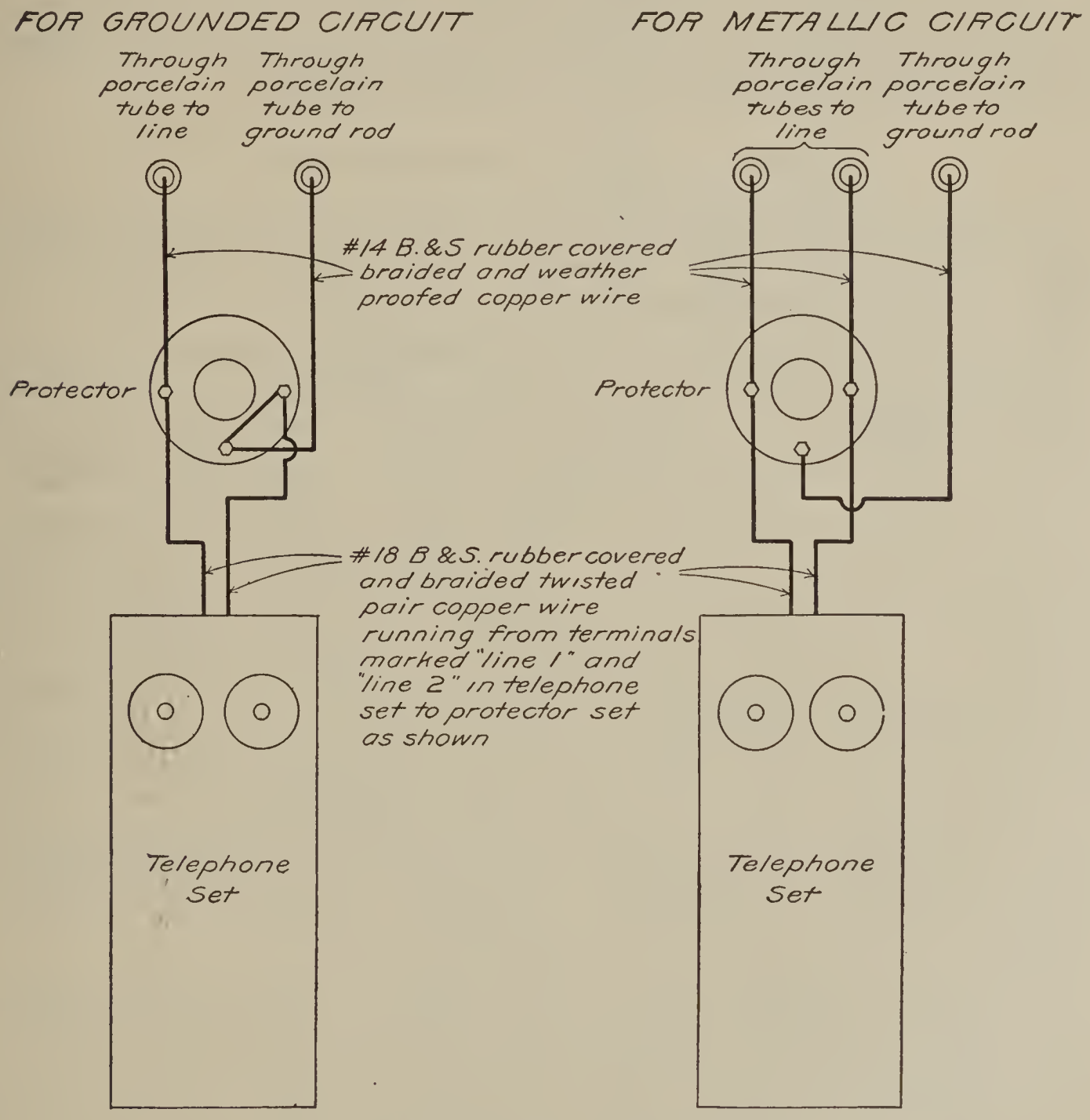


FIG. 27.—Wiring diagram for telephone station.

The 58–F protector should be connected as follows: Connect the leading-in wire or wires to the fuse terminals marked "L" most distant from the protector blocks and the inside line wires to the other end of the fuse terminals—that is, the end nearer to the protector blocks. Connect the ground wire with the terminal marked "G." In the case of a grounded line use only one of the fuses, though a short wire should be run on the end of the protector that contains the protector blocks, from the terminal marked "G" to the terminal at the side of the protector blocks that is not being used by the main line (fig. 27).

Protection from pipes.—Wherever practicable wires should be placed above all pipes or other conducting material. When a crossing is necessary the wire should be protected by two wrappings of insulating tape, the latter extending at least 1 inch each side of the pipe or conducting material.

Separation from light and power lines.—When it is necessary to cross an electric-light or power wire in the building there must be a separation of at least 6 inches, unless the telephone wires are incased in a circular loom or porcelain conduit. When so incased the conduit should project at least 6 inches on each side of the electric-light or power wire and be firmly secured against slipping.

LOOKOUT-STATION TELEPHONE SETS.

The 1336–J telephone, special Forest Service type, contains a 2,500-ohm unbiased ringer and condenser. The 1336–K telephone contains a 1,600-ohm unbiased ringer and condenser.

An iron-box telephone set outdoors should be mounted on a post in preference to a tree or topped tree. The iron case of the box should be grounded by wrapping a wire under the head of one of the mounting bolts when the latter is screwed in and then running it to the ground rod (fig. 28). A switch and protector mounting box should be attached to the post. The line wire should be properly dead ended on a bracket and insulator located on top of the post and extended to the switch by means of No. 14 B. & S. rubber-covered, braided, and weatherproofed copper wire. This wire should then extend from the opposite side of the switch to the line terminal of the protector and from there to the proper terminal in the telephone set, through the hole in the latter provided for the purpose. The same kind of wire should extend from the ground rod to the ground terminal of the protector and to the proper terminal in the iron-box telephone, through the hole provided in the latter.

If this set is employed on a metallic circuit, a double-pole, single-throw switch should be used (fig. 28). From each of the line wires an insulated copper wire should extend to a switch, and from the opposite terminal to its proper terminal on the protector, and thence into the iron-box set. The latter is grounded from the mounting belt, while another wire runs from the ground terminal of the protector to the ground rod.

Installations of this character may be placed on lookout points where there is nothing but rock. The post may be bolted to the rocks and the ground rod located wherever a suitable place can be found, even though it is a considerable distance away. In this case the wire to the ground rod is run in the same manner as line wire is run. Metal brackets and fixtures may be used to support the line wire along the side of the rock, with extension bolts if required.

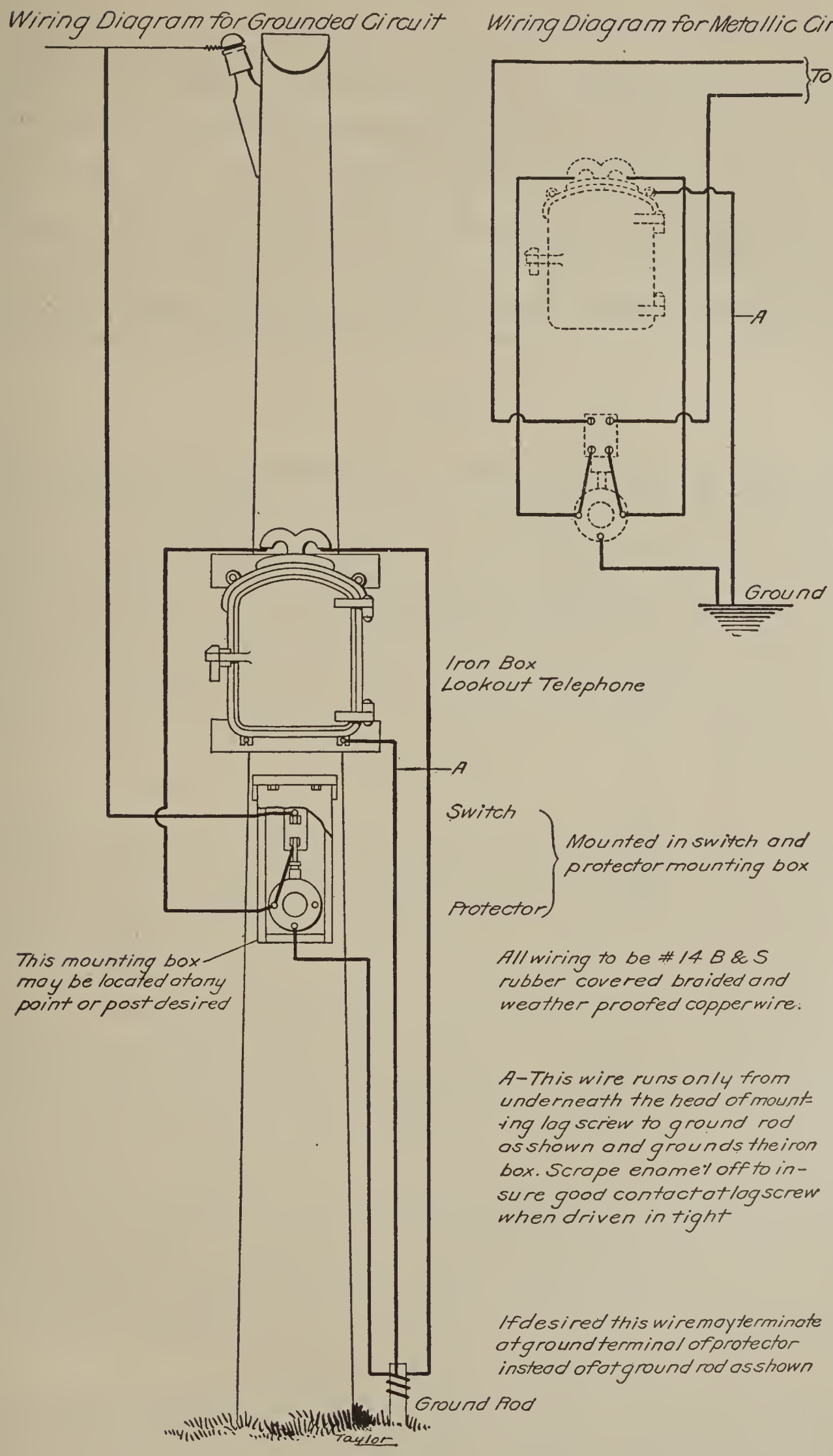


FIG. 28.—Wiring diagram for lookout telephone station.

MAINTENANCE.

Inspection of telephone lines should be made regularly during the fire season, and special inspections by the ranger or other officer in charge immediately after a severe wind, snow, sleet, or electrical storm, and after fires. Rangers and guards when on patrol duty should watch the telephone lines, cut out any trees that may have fallen across them, and make any other necessary repairs. Tests should be made at a certain hour each morning during the fire season to see that no trouble exists.

Each forest supervisor should establish a regular organization on his Forest for the proper inspection and maintenance of each Service line.

LINE.

The entire line should be gone over thoroughly once a year, preferably before the beginning of a fire season. Each pole should be inspected; brackets, insulators, and tie wires which are broken should be properly replaced; and all foliage and interfering timber cleared away. Poles should be examined for butt rot and for twist. In the latter case it should be determined whether the pole has twisted to an extent to permit the line or tie wire to touch it. Loose guys or braces should be tightened and all loose or badly corroded joints renewed.

TEST STATIONS.

On lines more than 15 miles long one or more test stations should be established. These should be so arranged that the line may be looped into the house or building where the telephone is and through two switches placed near the latter (fig. 29). The instruments should be connected to these switches in a way to make it possible to cut off either end of the line, while the instrument remains on the end desired, and yet bridge to the line when both switches are closed. In this way the line may be cut by the switches for testing in either direction and line trouble more readily located between certain definite points.

By opening switch "A" the telephone is connected to one side of the line only. By closing switch "A" and opening switch "B" the telephone is connected to the other end of the line. By closing both switch "A" and "B" the line is in normal condition. Care should be taken after making tests that both of the switches are left in contact, otherwise no calls can be sent through.

If desired, provision can be made at any point on a line for testing it in either direction with a portable telephone. In such cases the line wire should be cut and dead ended from both directions on the same pole with a two-piece transportation insulator (or two brackets).

The ends should be left long enough after dead ending to be joined together with a test connector, so as to complete the circuit.

The voltmeter test stations might be used at logical switching centers. The district forester should be consulted, however, before equipment of this kind is purchased.

EMERGENCY WIRE.

Emergency wire is a No. 20 B. & S. gauge wire, consisting of 10 strands of No. 30 B. & S. gauge hard-drawn copper wire twisted together and insulated with a double-reverse close serving of cotton

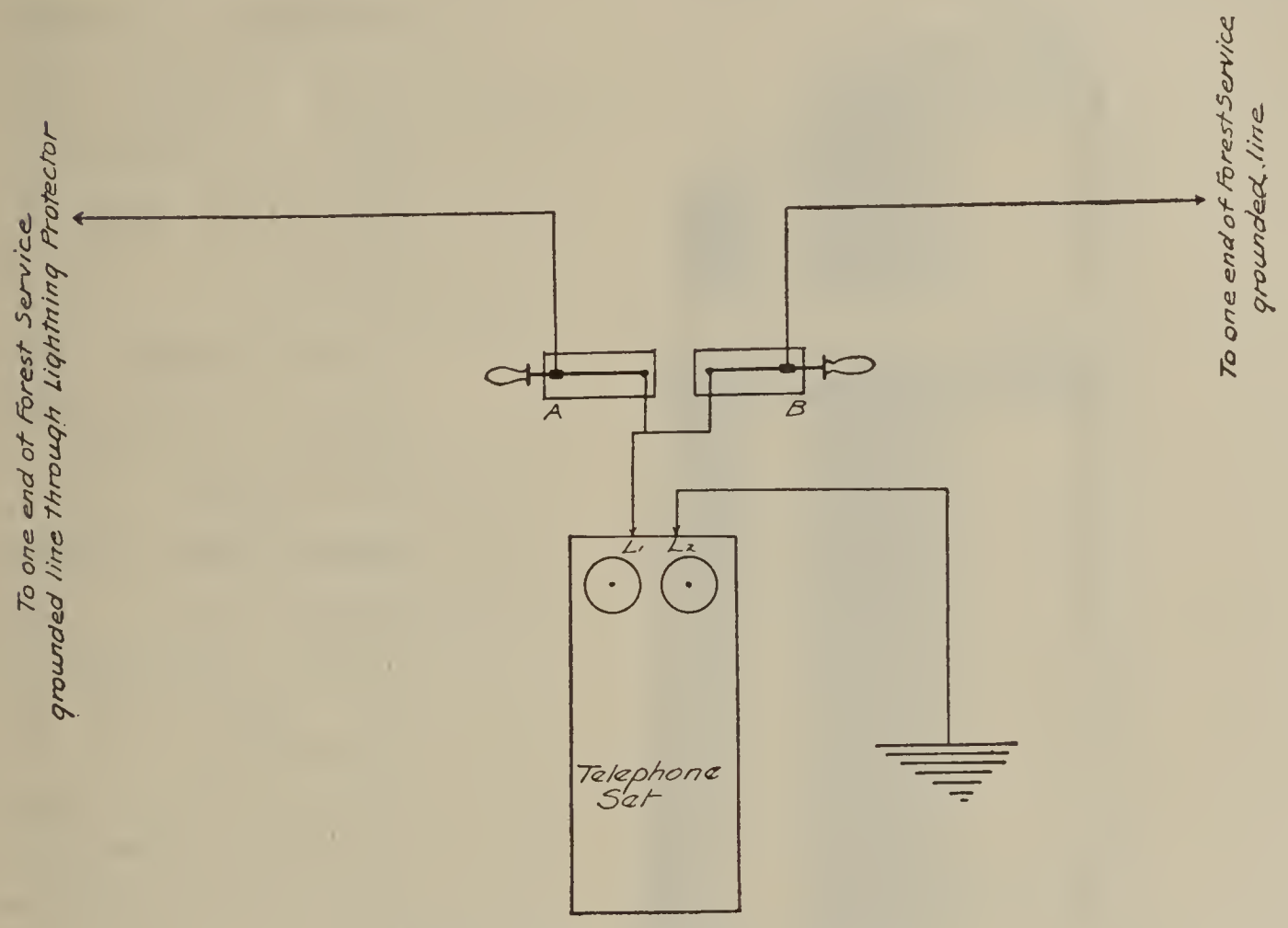


FIG. 29.—Method of installing test station.

waterproofed with asphaltum compound. Since it is easily broken, it will not be used as a substitute for permanent line construction. Its use should be limited to emergency purposes.

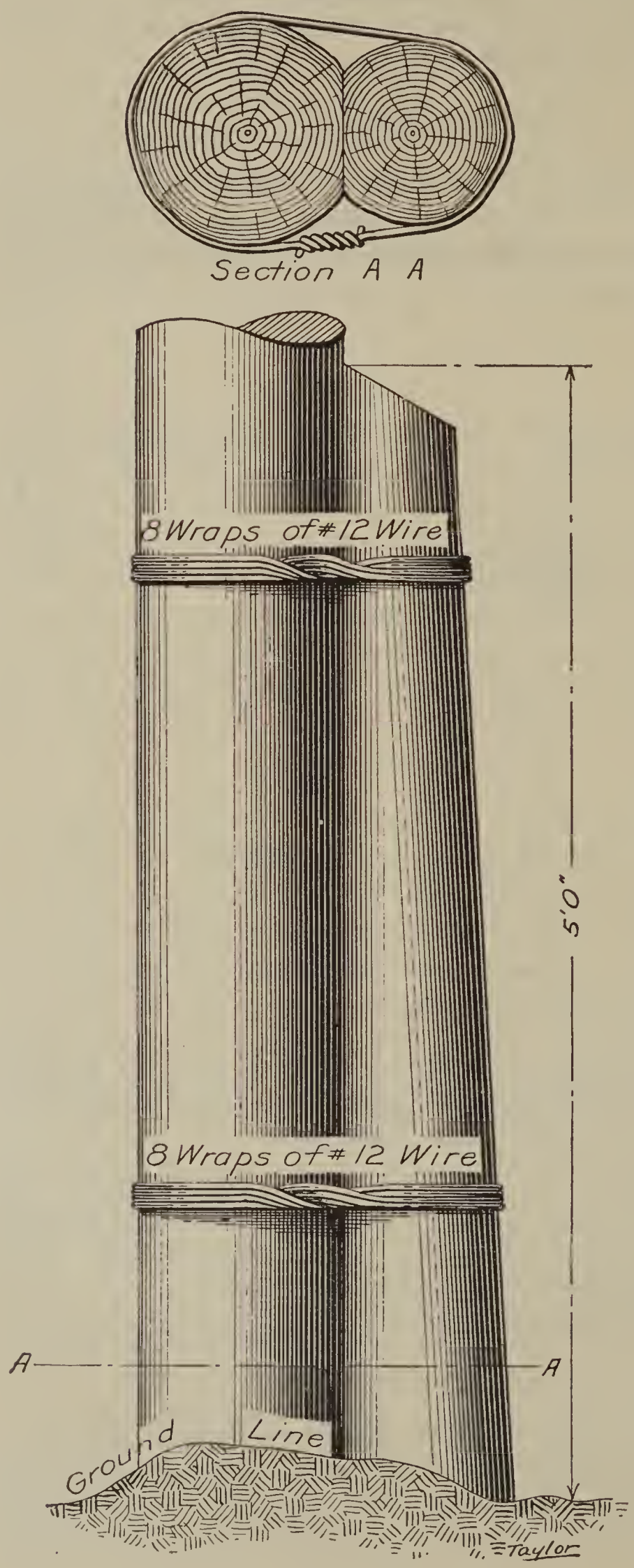
Emergency wire should be constantly inspected while in use. When being strung, it should be kept off the ground wherever possible and be anchored at corners and tied about every quarter mile. Frequent coils of slack should be left for repairing breaks.

Experience will show where emergency wire can best be employed.

DISCONNECTING BRANCH LINES IN WINTER.

Since any trouble occurring on branch lines to a lookout point or a ranger station may injure the entire telephone system, such lines should be disconnected from the main line whenever they will be out of use for a considerable period, especially during the winter.

The disconnection from the main line may be made by a suitable pole switch properly housed and mounted, as shown in figure 22 or 23. A Fahnestock test clamp may also be used for this purpose.



FIE. 30.—Reinforcement or stub of poles.

STUB REINFORCEMENT FOR POLES.

Poles that have become seriously weakened by butt rot near the ground line should be replaced, except where conditions are such as to warrant reinforcing them by means of a stub of long-lived timber. A stub should ordinarily be used where suitable pole timber is not available and to reinforce poles that are sound above the ground, irrespective of their condition at the ground line.

The stub or post should be peeled and shaved and roofed, as shown in figure 30. The sides of the post and of the pole which come in contact should be faced above the ground line to a width of 2 or 3 inches, so as to give a greater bearing surface.

The diameter of the stub at the ground line should be at least as great as would be required for a new pole. The weaker the pole to be reinforced the stouter should be the stub.

The stub should ordinarily be set to a depth of 4 feet and should extend out of the ground about 5 feet, making the total length from 9 to 10 feet.

Strain on the weakened pole should cause it to bear against the stub. For this reason stubs in general should be set in line with the line wire. Where there are prevailing strong winds from one direction, however, it should be set on the side opposite. On curves and at corners a stub should be set on either side of the pole in line with the line wire. Where any special strain exists, the largest post available should be used.

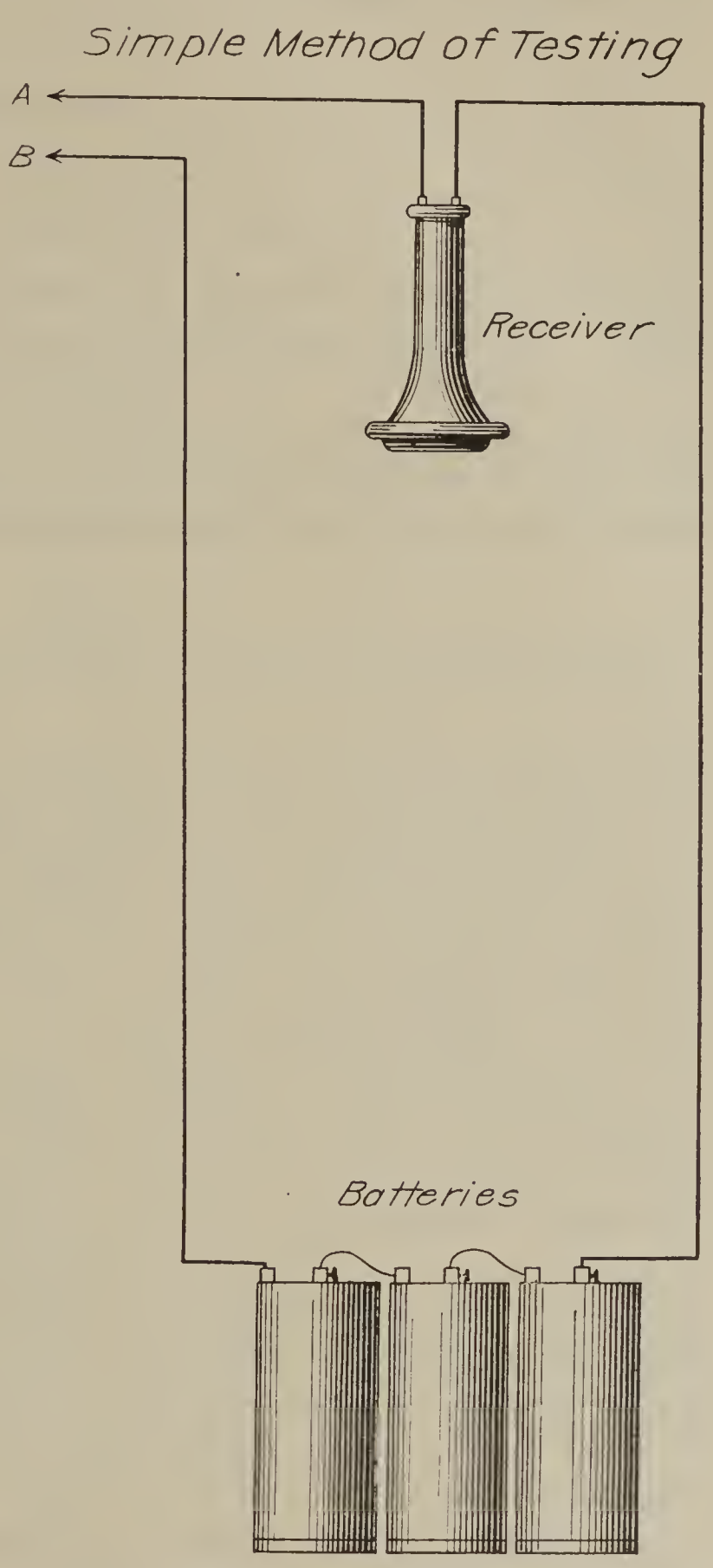


FIG. 31.—Receiver test.

Wrappings consisting of No. 12 iron wire should be placed as indicated in figure 30. Each wrapping, consisting of eight turns around both pole and stub, should be made as tight as possible with pliers or other devices and the ends twisted together with not less than six turns and then stapled to the pole. The wires may be twisted very tight if an iron rod about one-fourth inch in diameter or one arm of cutting pliers is inserted between an equal number of turns at a point opposite the line of contact. Both sets should be twisted at the same time.

Where it is impossible to secure sufficient strength by wrapping the stub and the pole together by wire, through bolts should be used. The nuts, washers, and bolts should be of galvanized iron and the washers about $2\frac{1}{4}$ inches square.

No back filling should be done until after the stub is in place. The same method should be followed as described under the heading "Setting poles," page 19.

APPARATUS.

All telephone apparatus at stations and elsewhere on the line should be carefully inspected for loose connections or other defects. The inspector should call up the terminal or intermediate stations from each instrument and note particularly how the generator of the instrument rings its own bell and how the bell rings at the station called. The called station should ring back in order to test the bell at the calling station. In making tests it should not be taken for granted that something is wrong if an answer is not immediately obtained. If unable to get the station after several attempts, call another station and try to get a test with it.

BATTERIES.

All dry batteries on the line should be replaced at least every 12 months, and more often if necessary. As far as practicable, all the batteries on a line should be renewed at the same time, preferably at the beginning of the fire season. A fresh battery should not be connected to an old one. The inspector should note whether or not battery connections have become loosened. In putting dry batteries back into a telephone, the inspector should see that the zinc binding post on one battery does not touch the zinc binding post on an adjacent battery (fig. 24).

An emergency test to determine whether or not a dry battery is absolutely dead may be made by moistening the finger and gripping the zinc binding post, and then touching the tip of the tongue to the carbon binding post. If a very slight acidulous taste is noted, the battery is not absolutely exhausted, although it may be sufficiently so to be incapable of giving good transmission. In extreme emergencies, exhausted dry batteries can sometimes be temporarily revived to give sufficient current for sending an important message over the line by driving holes with a nail through the zinc shell and allowing water to soak in through them.

Lightning protectors should be inspected, and cleaned if necessary, after all electrical storms. The No. 60–E protector is cleaned by unscrewing the brass cap from the porcelain base, removing the metal protector blocks, and removing from them any soot or smoke, or pits which cause the blocks to touch each other. Both conditions are the result of lightning jumping across the air gap provided by the mica separator. In replacing the blocks be sure to put the mica back. In localities where lightning is particularly bad and the stations are difficult of access two micas may be inserted between the blocks, thus increasing the width of the air gap.

OILING GENERATOR.

Once every two or three years *one drop* of typewriter oil or "3 in 1" will be placed in each of the places provided with oil cups. Great care should be taken to see that no oil falls on any of the contacts or rubber bushings of the generator.

TROUBLE.

BROKEN CONNECTIONS AND OPEN COILS.

On the instruments that the Forest Service has adopted as standard the causes for trouble have been reduced to a minimum. Lightning is the greatest source of trouble.

The ringer coils, which are constructed of fine insulated wire wrapped around an iron core, occasionally burn out. When this happens it is necessary to substitute a new coil. The armature [1] in the generator may also burn out, necessitating replacement. In the receiver the small coil of insulated wire wrapped around the end of the permanent magnet is sometimes burned out by lightning or heavy outside currents.

The following methods of testing may be used to locate trouble as just described: Connect one side of a receiver to one pole of the battery. If when the other side of the receiver is touched to the pole of the battery no click is heard, the receiver is open.

By the use of the receiver, if in serviceable condition, and the batteries, as shown in figure 30, any of the wire coils may be tested.

A test of the generator may be made by disconnecting the instrument and placing the moistened tips of two fingers over the two screw binding posts on the end of the generator. If the latter is in adjustment, current will be felt when the crank is turned. If no current is felt, probably the armature of the generator is open, and a new armature must be obtained.[2]

It is impossible to talk through the transmitter when the induction coil is open, when the batteries are weak, or when there is a loose connection somewhere in the instrument, as at one of the connections on the batteries or else at the switch hook.

DETECTION AND REMEDY.

Trouble in any place is likely to affect the entire system. Inexperienced persons should not be allowed to tamper with telephone instruments. It is usually well to have a spare telephone on each Forest which can be temporarily installed while a telephone or the

---

[1] The part in the generator that revolves between the permanent magnets. This is composed of two windings around an iron base on opposite sides of the center. The generators used on some sets are protected to a certain extent by means of a "shunt."

[2] The hard-rubber bushings sometimes carbonize, due to oil or grease getting on them, and cause generator trouble.

part of it that is out of order is sent to some reliable telephone man for inspection, repair, or readjustment.

In general, telephone trouble may be in connection with (1) signaling, or (2) talking and hearing. The generator furnishes current for signaling or ringing the bells, sending a current over the line to

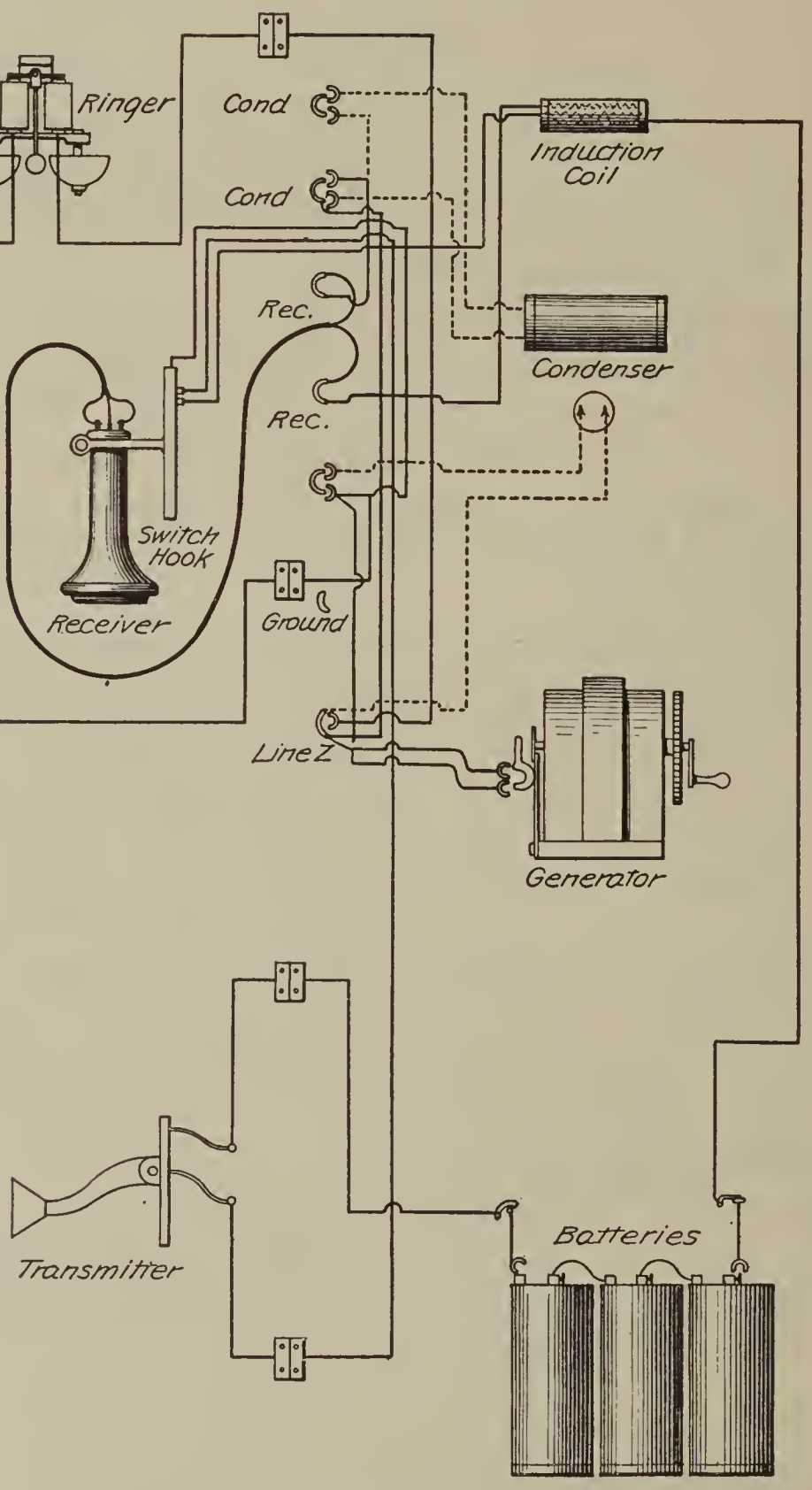


FIG. 32.—Wiring of 1317 telephone set.

all bells on its way to ground. The generated current is intermittent, and jumps to the ground or is greatly weakened by groundings instead of flowing along the line. The batteries furnish current for conversation only. It is possible to talk over a wire even when there are slight grounds through trees or through the line wire touching the ground in dry places, but it is not possible to signal.

Troubles may arise from various causes: The line wire may be broken, down on the ground, or the current may be leaking through contact with foliage, trees, poles, or other lines. The trouble may be at the stations or at pole switches; it may be caused by the switching arrangements at the terminal of the line, or it may be due to trouble on other connecting lines. Trouble is often caused by poor ground connections or bad splices and joints; in many cases the lightning protector needs cleaning.

The most common troubles, with the cause and remedy, follow:

No. 1. You can not ring up anyone; your generator handle turns hard; your bell does not ring when you turn the generator.

When testing to discover the cause of this trouble the receiver should be left on the switch hook. First disconnect the two wires which enter the telephone set from the terminals marked "L–1" and "L–2," and screw down the connections on the wires coming from the ringer. Now turn the generator. If it turns easily and the bell rings well, the trouble is not in the telephone set.

Then connect the line wires to "L–1" and "L–2" terminals and disconnect the line wires from the protector, leaving the inside wires to the telephone set attached to the protector. Now turn the generator handle. If it is difficult to turn, remove the protector blocks from the protector and try the generator again. If it turns easily, clean the protector blocks, replace the thin piece of mica between them, and put back into the protector. Now test the generator again, and if it turns properly, connect the line wires to the protector and see if the telephone set works as it should.

If the generator turns properly when the line wires are disconnected at the protector, but is difficult to turn when the protector blocks have been cleaned and the line wire again attached, the trouble is either in the wiring between the protector and the pole or out on the line or in the wiring apparatus at one of the other stations. Carefully examine the wiring and the line for a place where one of the wires crosses another (if the line is metallic) or where the main line or drop wire touches some ground connection. If in a metallic line the wires are crossed, the generator crank will turn hard as above described. This is also true of a grounded line if the wire becomes crossed with some foreign ground. On a metallic line, if one side of the wire is touching a ground, a humming noise will be noticeable on the line.

If the generator turns hard even when the line wires are disconnected from the telephone, look for incorrect wiring or crossed wires in the set or for carbonized bushings on the generator. When this latter trouble exists the odor of burning rubber is noticeable when the door of the telephone is opened.

If every station on the line has the same trouble, call for an inspection of the protector at each station, or look for trouble along the pole line or in the terminal arrangements where the line is connected to a switchboard or to another line, and inquire out on that line, if necessary, or disconnect from it temporarily.

No. 2. You can not ring up anyone; your generator handle turns easily; your bell rings when you turn the generator.

If a metallic line, look for a loose connection at line "1" and "2" of the telephone set. If a grounded line, look for a loose connection on the main line at line "1" or on the ground wire which is attached to line "2" in the instrument. Look for a loose connection at the protector or where the inside wiring is attached to the outside wires. Look for an open fuse. If trouble is not found at these points look for a broken wire or a poor ground.

No. 3. You can not ring up anyone; your generator handle turns easily; your bell does not ring when you turn the generator.

Look for a loose connection or a broken wire in the telephone set. See that your ringers are in proper adjustment. It may be that one of the wires to the generator is disconnected from one of the line wires, or one of the ringer wires may have become loose or broken.

No. 4. You can not ring other places on the line, or only feebly; your bell rings all right when you turn the generator.

Look for a loose connection where line connects with telephone set, where line connects to protector, or at the ground. It is possible that the trouble may be due to a poor or corroded splice in the line wire or to contact between the line wire and trees, poles, or other lines. In the case of grounded lines be sure that the ground at the telephone you are trying to call is in proper condition. Be sure that your own ground is in the same condition.

No. 5. Your bell does not ring; other places on the line ring all right.

Look for a broken wire or loose connection in the wires coming from the ringer. If the connection and wire are all right, see that the ringer is properly adjusted.[1] Make a test on your ringer coils to see that they have not been burned out as heretofore mentioned.

No. 6. You can hear others all right; others can not hear you.

Look for a loose connection or broken wire coming from the transmitter, battery, induction coil, or switch hook. See if the connections to the induction coil are all right. If this examination does not show anything wrong, thump the underside of the transmitter lightly with the hand, as the carbon granules in the transmitter may

[1] The clapper ball of a ringer should move freely. In most cases it should have a movement of about one-sixteenth of an inch. The gongs should be so set that the clapper ball strikes but does not rest against them when thrown to either side.

have become packed. If this fails to improve matters the trouble may be due to an exhausted battery.

No. 7. You can not hear others distinctly; others hear you all right.

Look for a loose connection or broken wire coming from the receiver, switch hook, or induction coil. Unscrew the earpiece from the receiver and brush out the inside and wipe off the diaphragm. Also brush off any particles that may have been collected on the magnets underneath the diaphragm. If the diaphragm is bent in, turn it over and replace the earpiece. Screw this on firmly, but not very tightly.

If this does not reveal the cause of trouble, unfasten the receiver cord from the terminals in the telephone set and while holding the receiver to the ear touch the two terminals of the receiver cord to the terminals of one of the dry batteries. If you can hear a click when the cord is connected in this, the receiver is all right and there must be some fault in the wiring. If you do not hear a click, it is probable that the receiver winding or the cord is broken.

No. 8. Neither you nor others can hear distinctly.

The trouble is probably due to some loose connection or poor or corroded joint in the wiring at the telephone station, or out on the line, exhausted batteries or poor grounds, or a loose lightning rod touching the line.

No. 9. The stations at the terminals of the line have increasing difficulty in ringing or hearing each other plainly.

This trouble may be caused by too many stations on the line, or too long a line for the size of the wire used, to ground rods located in too dry soils, or to corroded splices or poor joints. Any or all of these troubles may be combined with excessive line leakage through contact with trees, poles, or foliage. If fixing up the entire line improves the talking but not the ringing, see that all the telephones on the line have 2,500-ohm ringers. See that the generator crank shaft comes back into place after calling a party on the line. If this does not make the ringing satisfactory, cut off some of the stations or divide the line into sections, or rebuild the main line, using heavier wire. In extreme cases it may be necessary to build a copper metallic circuit. The fault may be due to similar conditions or poor maintenance on a foreign telephone line or switchboard to which the Forest Service line is connected.

CROSS TALK.

Cross talk occurs when two grounded lines are strung on the same poles. This interference with conversation is reduced as far as possible on a grounded line by good grounds at all subscribers' stations. Separate ground rods should be used for separate lines. If it is

desired to eliminate cross talk, the circuit must be made metallic and the standard method of transposition followed. By making one of the two lines metallic, cross talk is eliminated on the metallic line, but may still trouble on the grounded line.

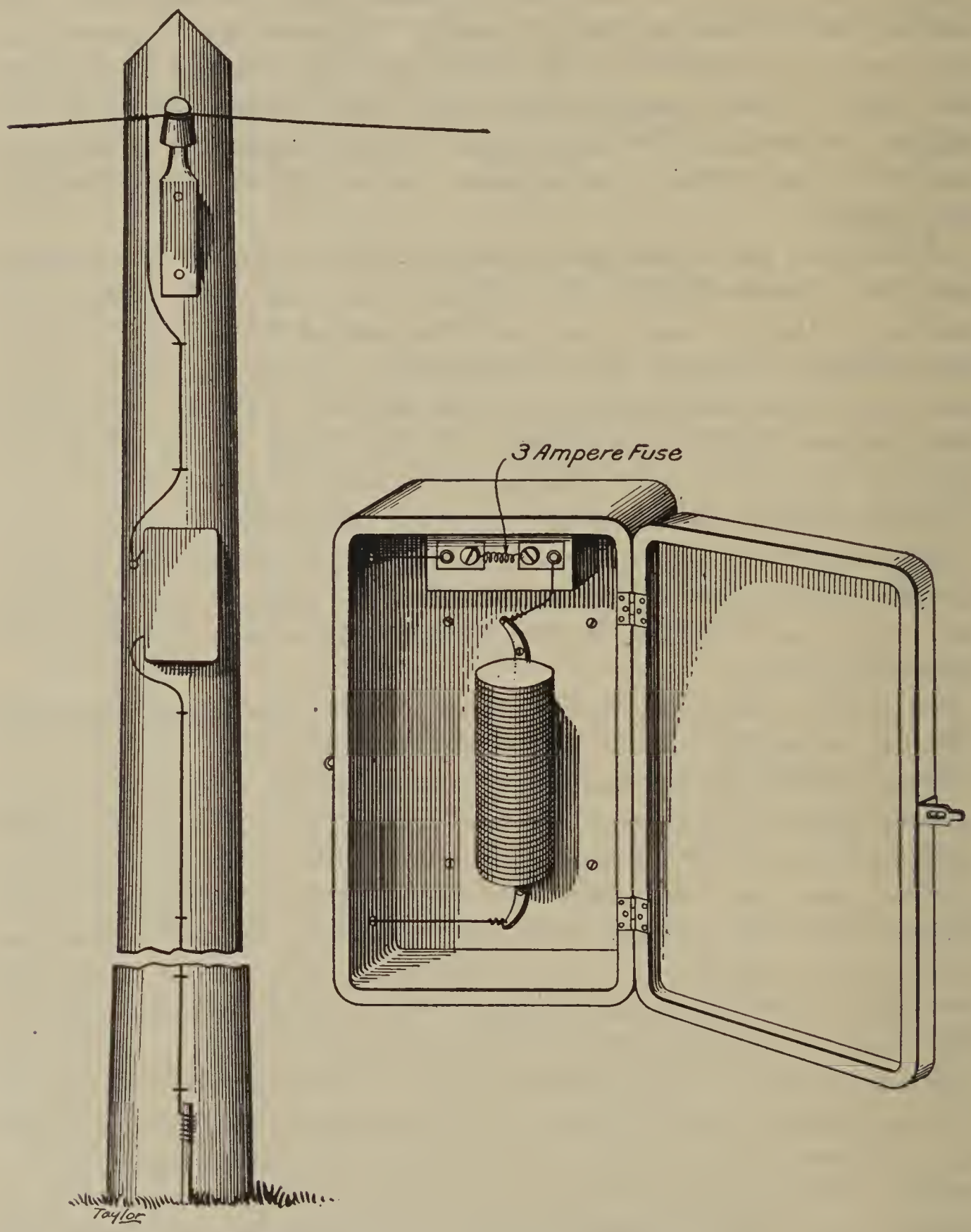


FIG. 33.—Method of draining line of static electricity.

STATIC ELECTRICITY.

A great deal of inconvenience may be caused by static electricity. There may be no trouble in the morning, but toward noon a frying noise is apparent and in the evening it is impossible to carry on a conversation. Trouble from static electricity is usually greater in high altitudes than at low.

One method of removing static electricity from a line is by the use of a lavite coil, or equal, with a resistance of 48,000 ohms. This coil should be installed along the line at intervals of from 3 to 10

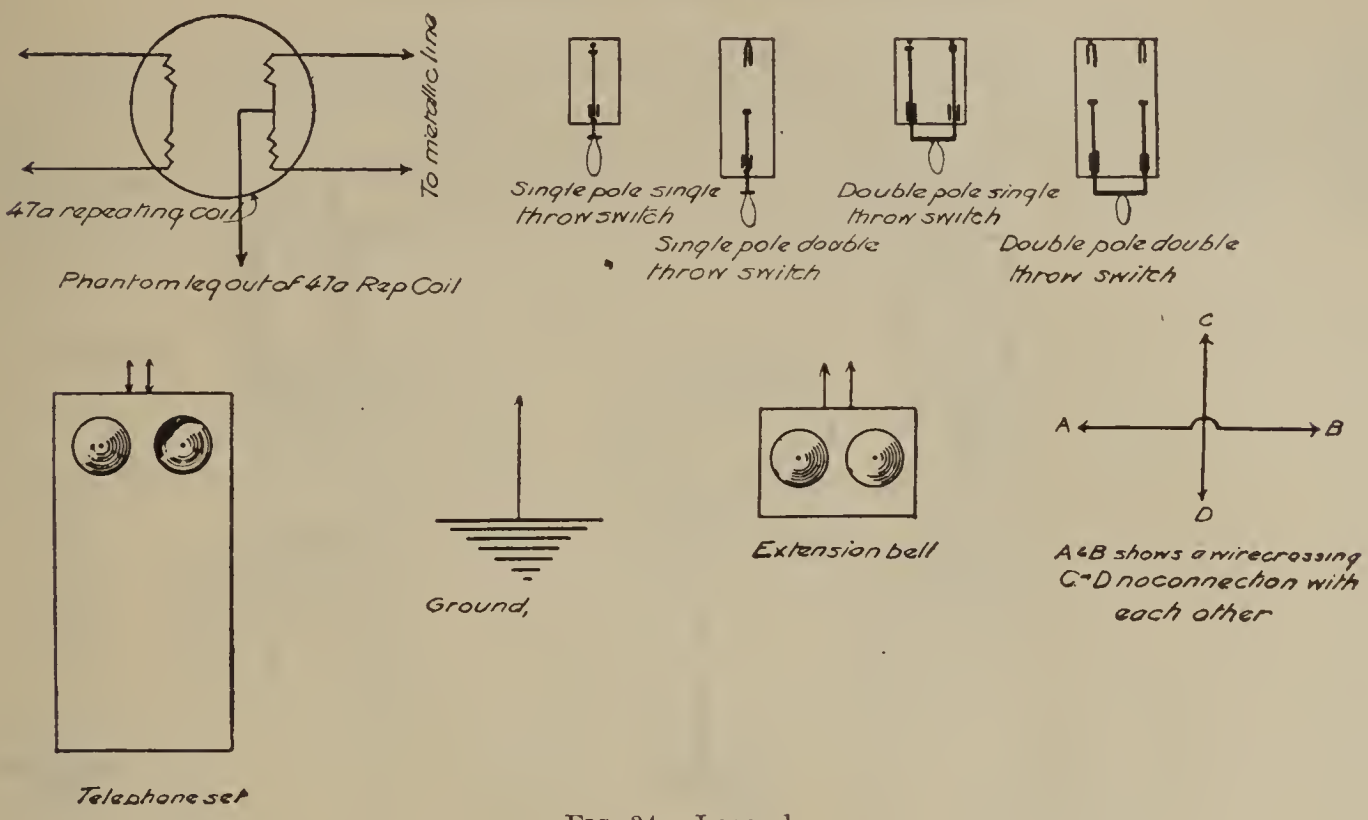


FIG. 34.—Legend.

miles, and attached to a ground line as shown in figure 33. In a metallic line two coils should be attached, one to each wire. The

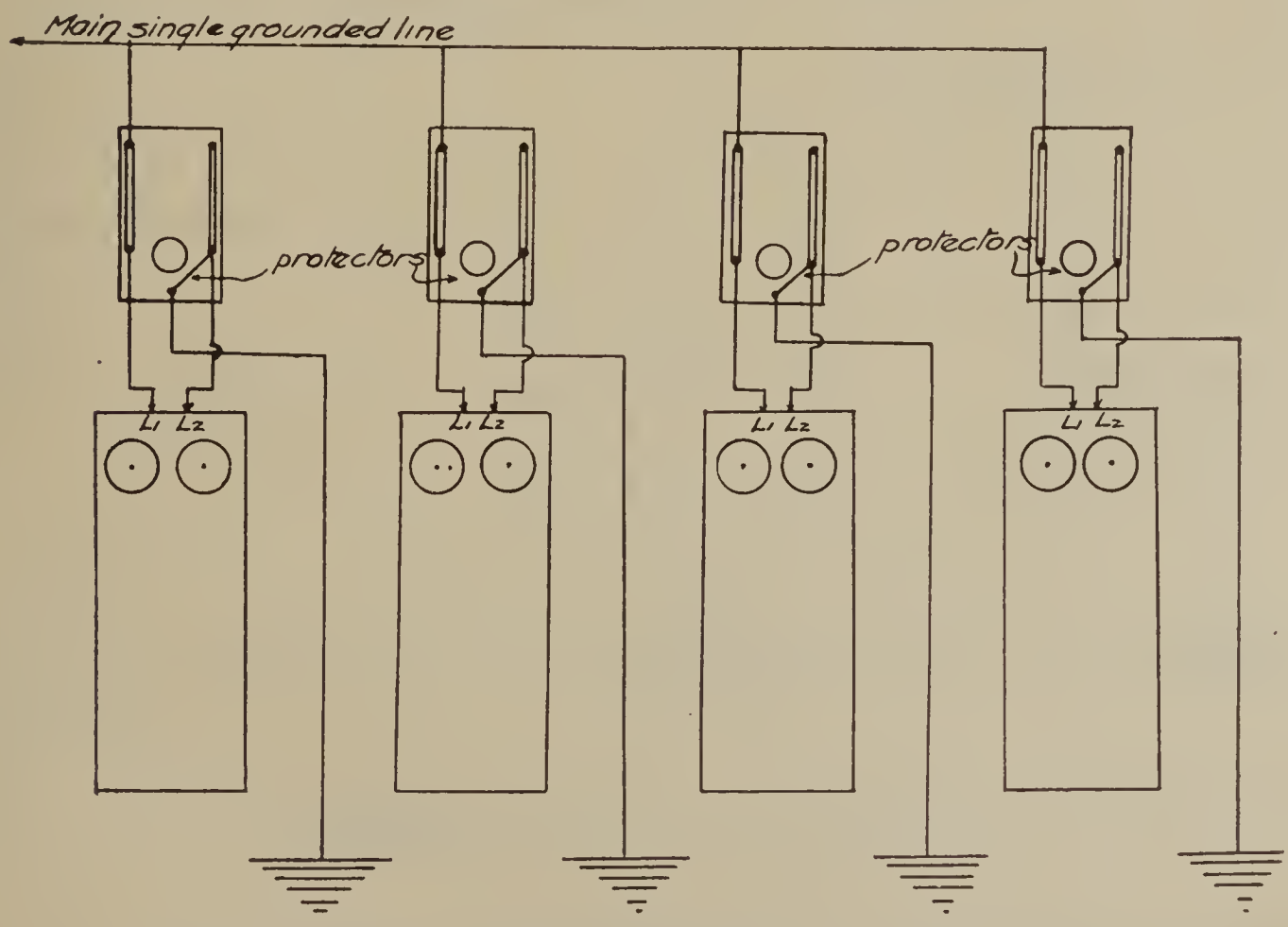


FIG. 35.—Connecting telephone on grounded line by bridging system.

same ground may be used for both coils. The coil should be inclosed in a small weatherproof box.

Another method of draining static electricity is by the installation of vacuum lightning protectors. These protectors should be

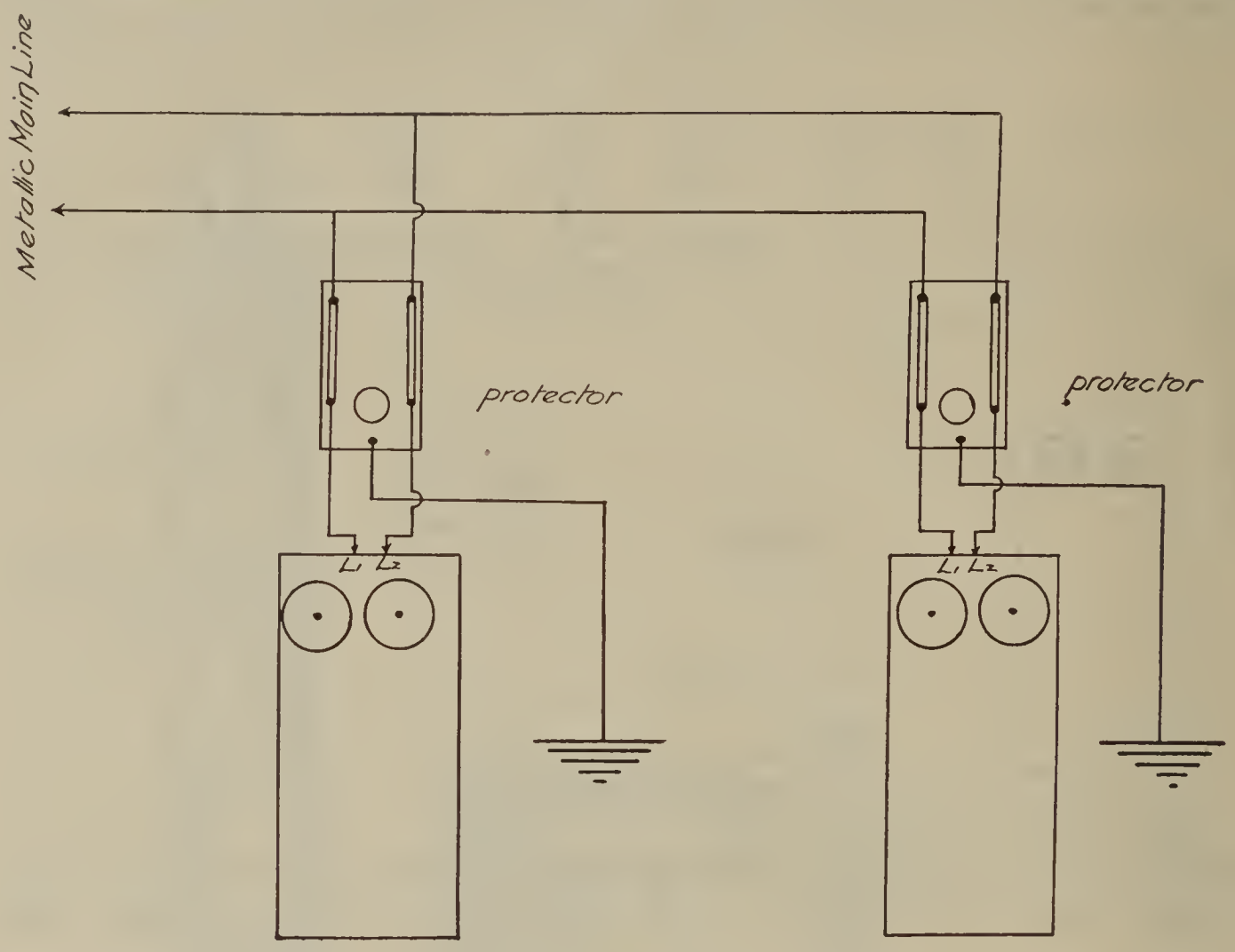


FIG. 36.—Connecting telephones on a metallic line.

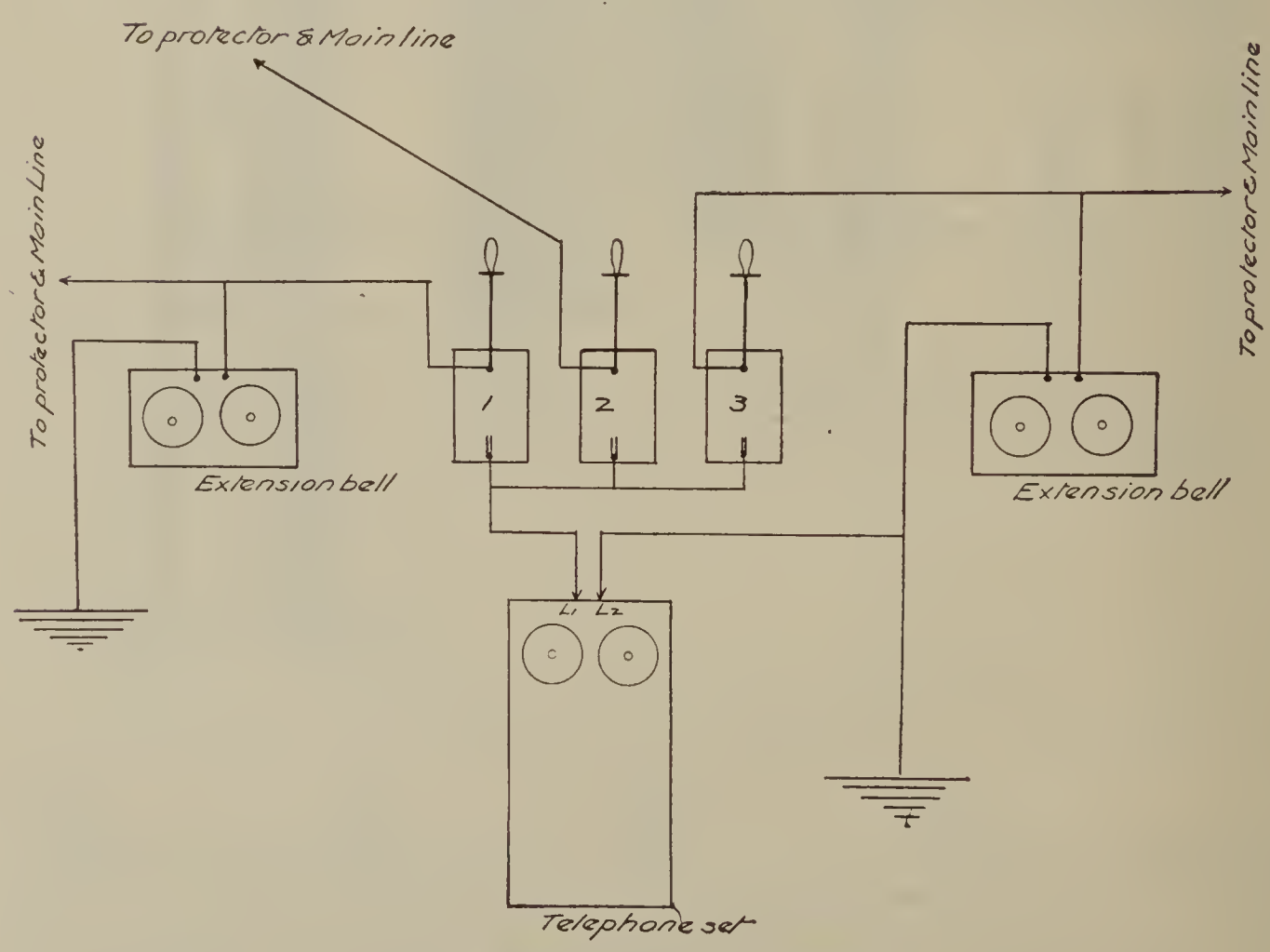


FIG. 37.—Switching station (first method).

installed in the same manner as the lavite coil, except that the fuse may be omitted.

It is sometimes necessary to make a study of static conditions, as the distance between coils is not the same in all cases. Before doing so the district forester should be asked for definite instructions.

SUPPLEMENTARY DIAGRAMS.

The following diagrams show graphically certain methods in telephone construction previously referred to in the Manual, and other methods of construction which may at times be found expedient, but which were not taken up in the preceding text.

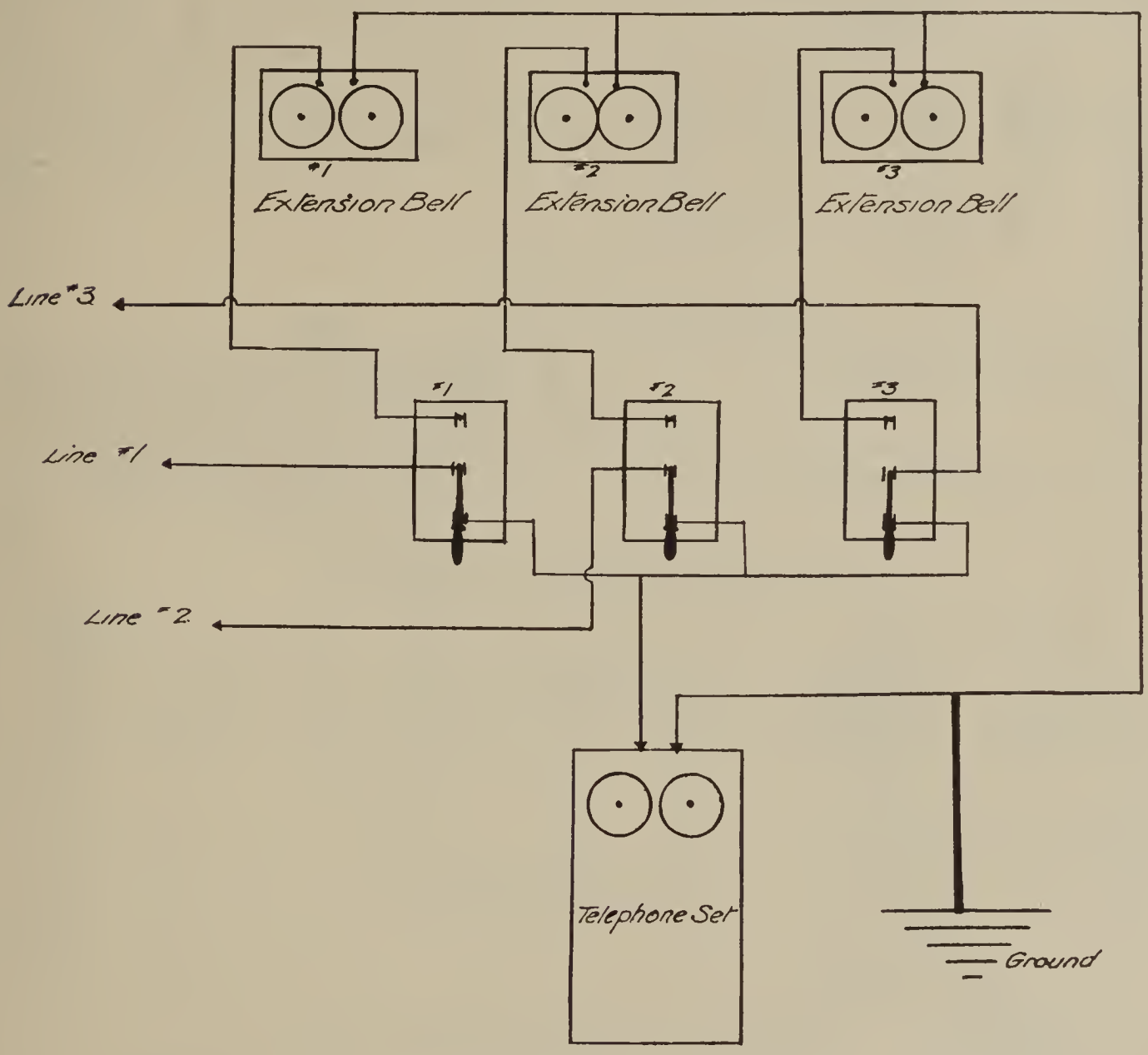


FIG. 38.—Switching station (second method).

Figure 34 is the legend which shows how the various parts of the telephone equipment are graphically represented in the succeeding diagrams.

TWO METHODS OF CONNECTING UP A SWITCHING STATION WHERE THREE GROUNDED LINES TERMINATE.

The method shown in figure 37 should be used where the three lines are not connected most of the time. It requires the following equipment: Two extension bells, one telephone set, and three

single-pole, single-throw, baby knife switches. With the three lines the two extension bells and the telephone remain across the line.

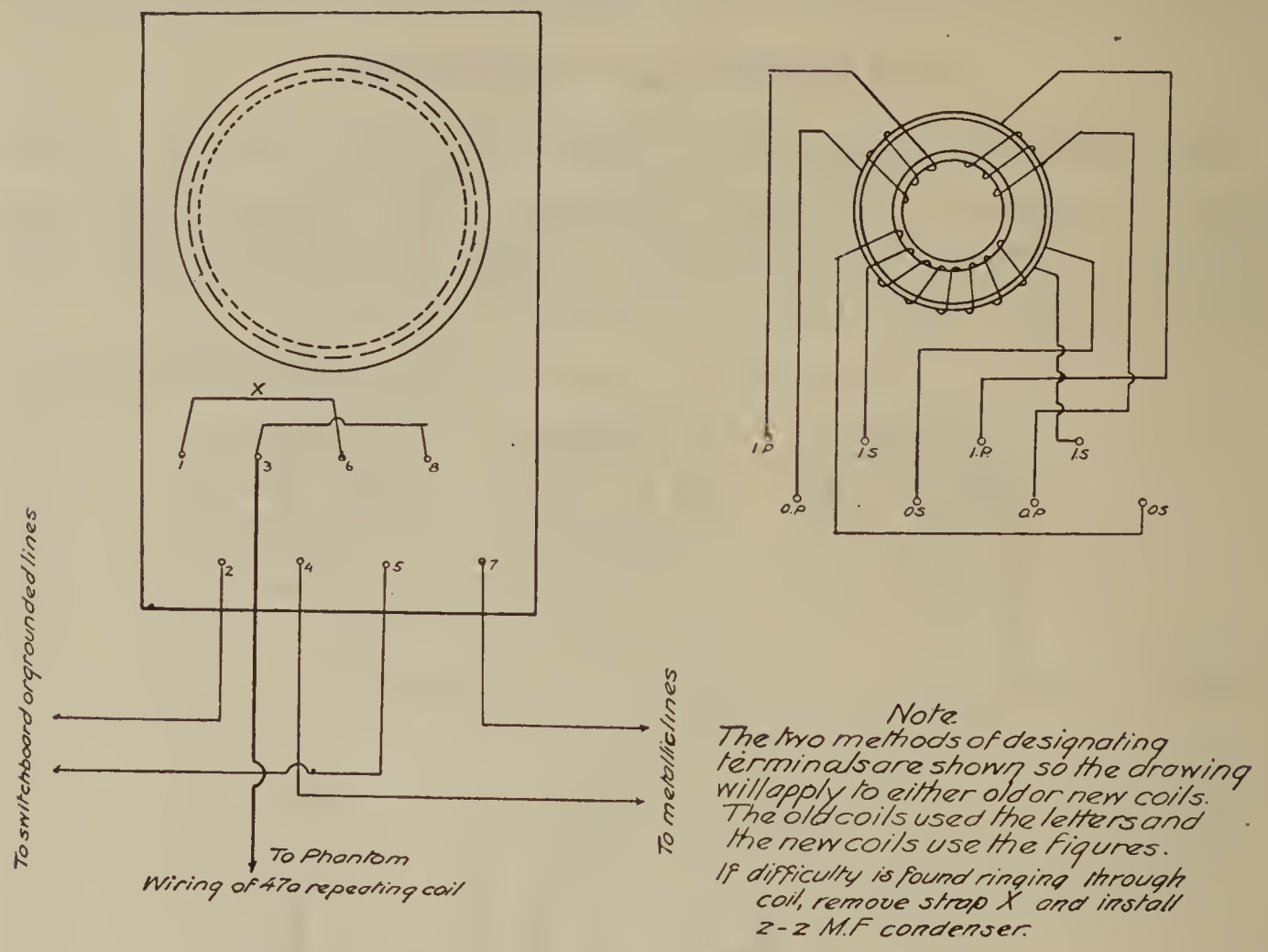


FIG. 39.—Connections on 47–A repeating coil.

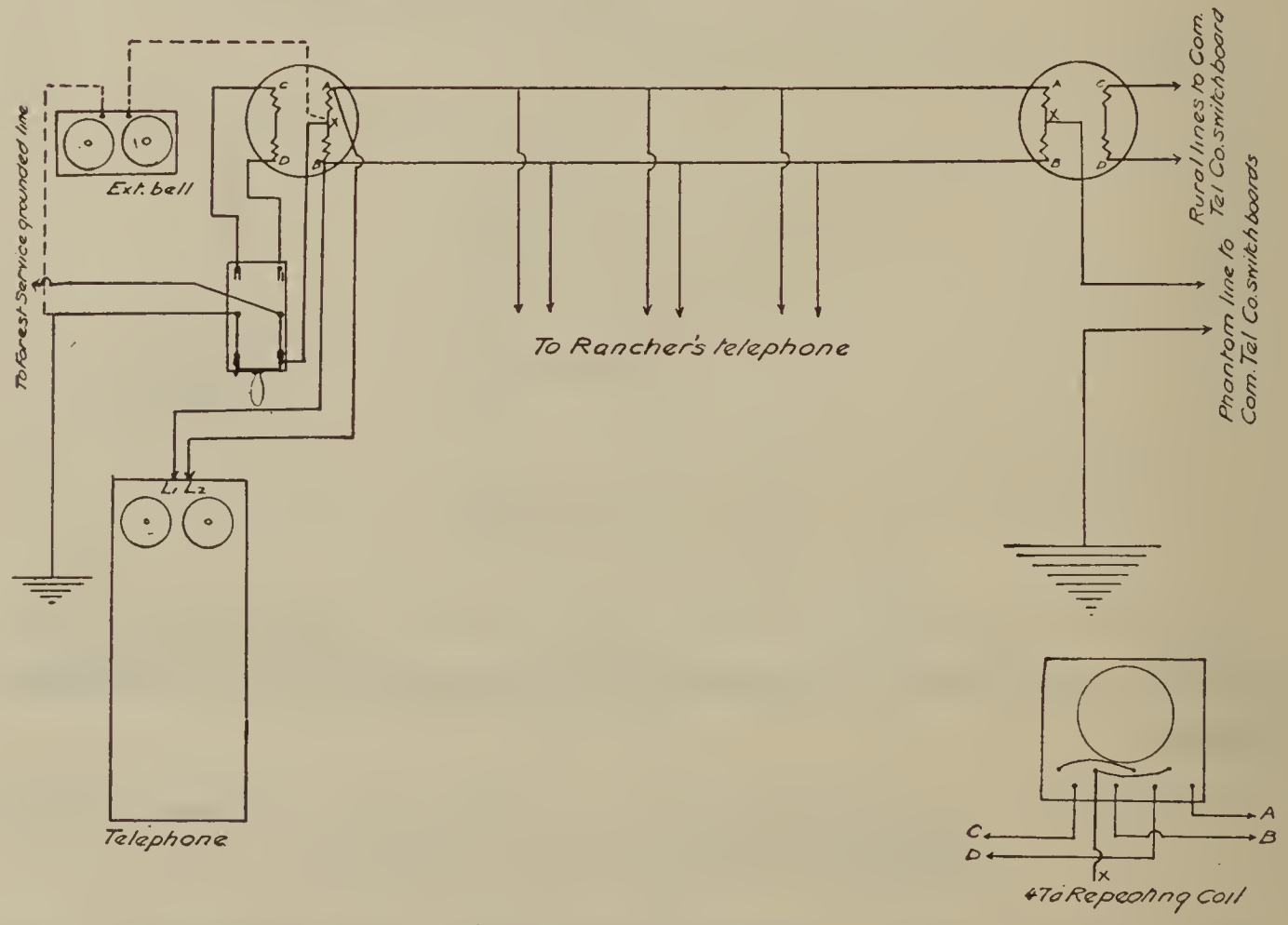


FIG. 40.—Phantom circuit.

The method shown in figure 38 should be used where the three lines are connected most of the time. It requires the following equipment: Three extension bells, one telephone set, and three

single-pole, double-throw, baby knife switches. With all the three lines connected just the telephone remains across the line, the three extension bells being disconnected.

CONNECTIONS ON 47–A REPEATING COIL.

The 47–A repeating coil is the most reliable and serviceable coil, both from a talking and signaling standpoint, and should be used wherever possible. This coil is also used for phantom work. By "phantom" is meant the utilizing of both sides of a metallic line for one wire. As illustrated in figure 39 an additional telephone circuit is thereby obtained.

Equipment necessary: One (1) 47–A repeating coil, or one (1) 8–A repeating coil ; two (2) lightning protectors ; one (1) galvanized-iron rod.

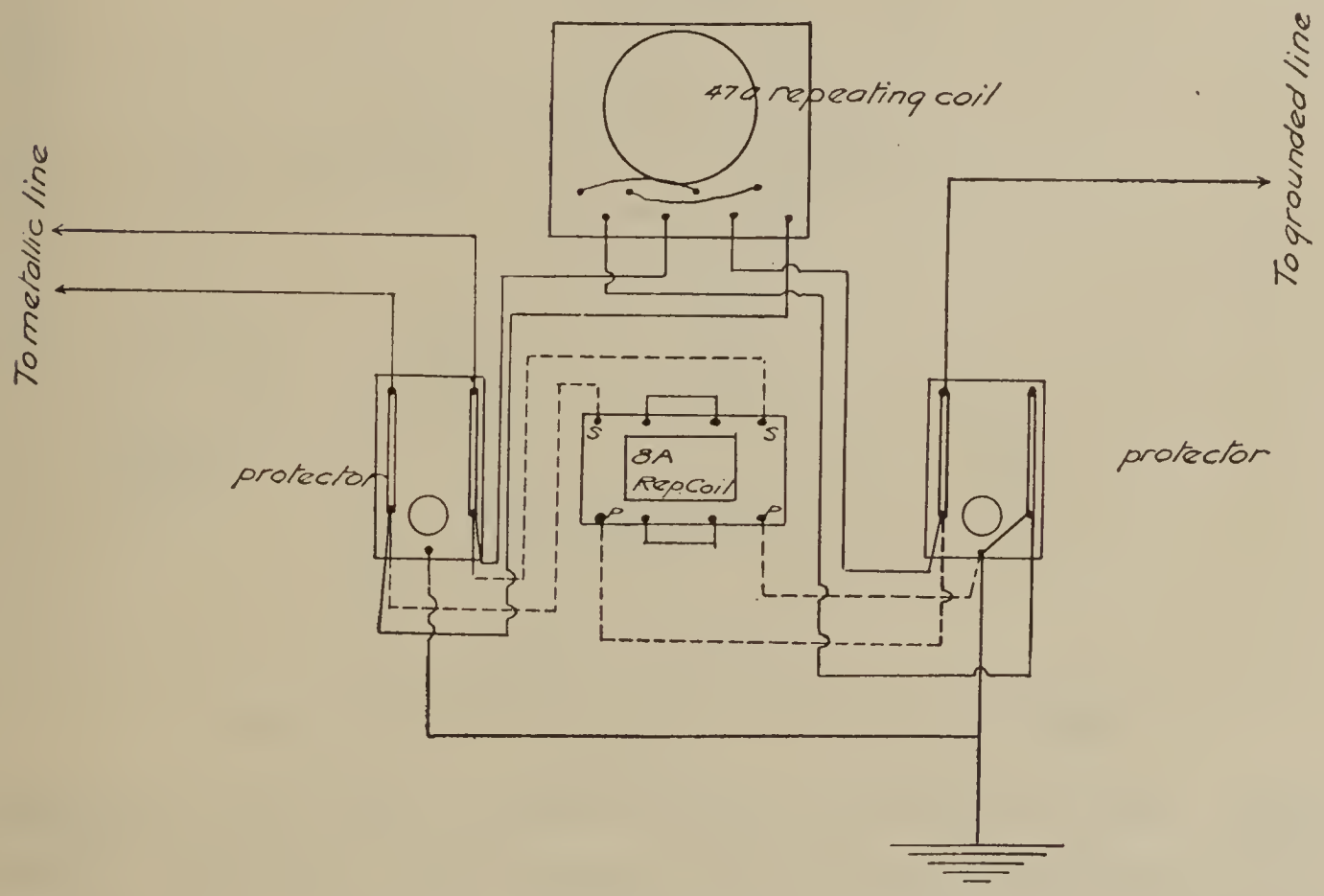


FIG. 41.—Connecting grounded line to metallic line.

This circuit shows the method of connecting a grounded line to a metallic line where connections are permanent and repeating coil and protectors are placed in a waterproof box on a pole. The dotted line shows the 8–A repeating coil in circuit while the solid line shows the 47–A coil in circuit. The figure is self-explanatory. The 47–A rather than the 8–A repeating coil should be used.

METHOD OF USING A GROUNDED PHANTOM CIRCUIT OUT OF A METALLIC RURAL LINE.

The following equipment is necessary: Two 47–A repeating coils, one extension bell, and one double-pole, double-throw, baby knife switch. By the method shown in figure 40, the Forest Service utilizes both wires for their line, the connection with the Service line being made at the end of the rural line circuit, thus eliminating the necessity of stringing in additional wire parallel to the telephone

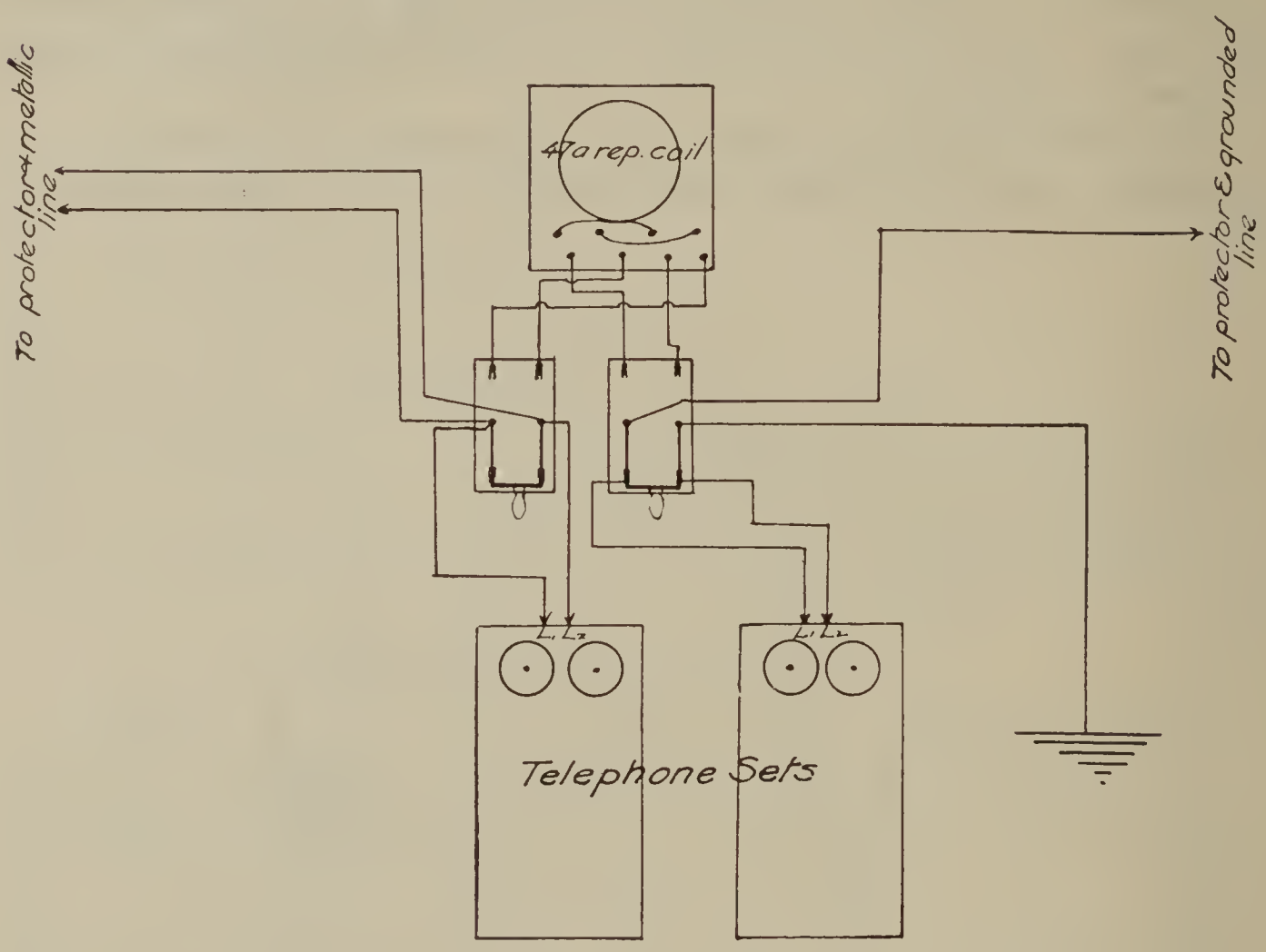


FIG. 42.—Connecting grounded line to metallic line by use of switches.

circuit. By the use of the phantom circuit a direct line is obtained to the exchange or town where the rural line terminates without interfering with subscribers on the latter. The circuit is so arranged that the grounded Forest Service line may cut on the metallic line direct through the 47–A repeating coil in an emergency. It is also arranged so that should any of the ranchers desire to talk to one of the stations on the Forest Service grounded line beyond the point where the rural line terminates, by calling the station at the end of this line the switch at that point may be thrown and direct connection had. This phantom circuit can only be built up where the metallic line does not parallel any electric-light, power, high-tension, or railroad wires.

A SWITCHING STATION WHERE A GROUNDED LINE MAY BE CUT THROUGH TO A METALLIC LINE WITH A 47–A COIL IN CIRCUIT.

Equipment necessary: One 47–A repeating coil, two double-pole, double-throw, baby knife switches, and one telephone set. This method (fig. 42) is used where connection is necessary with some commercial telephone company's toll line, one telephone being used on the commercial company's line and one telephone on the Forest Service line. If a subscriber of the commercial telephone company is using the toll station, the call on the Forest Service line may be answered at the same time, thus avoiding delay or interruption. When it is necessary to connect the grounded line to the metallic line, both switches should be closed, only one telephone being left across the line.

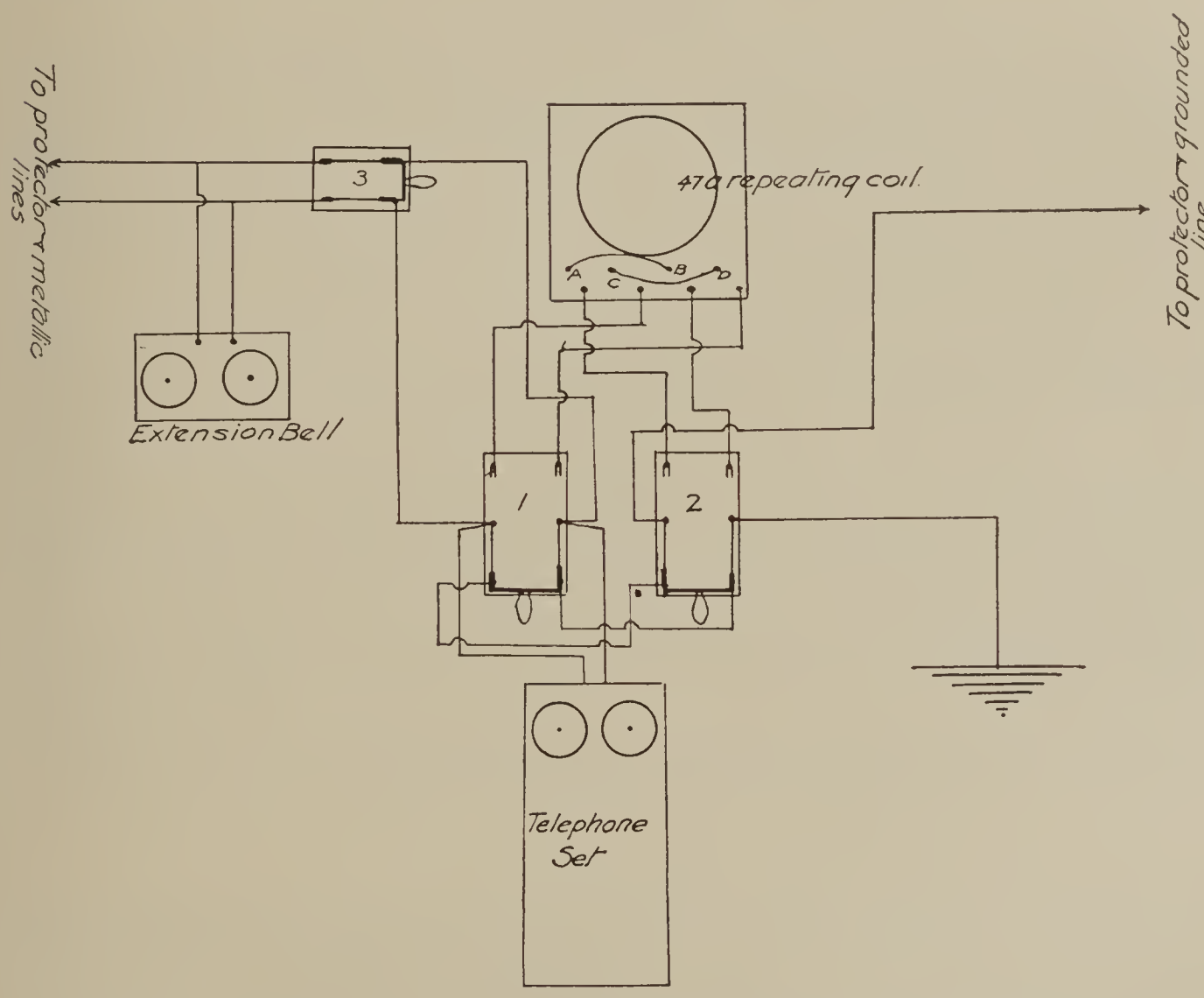


FIG. 43.—Connecting grounded line to a metallic line; switch and only one telephone used.

METHOD OF CONNECTING GROUNDED LINE TO METALLIC LINE SO THAT EITHER CAN BE USED WITH SAME TELEPHONE.

Equipment necessary: One 47–A repeating coil, two double-pole, double-throw, baby knife switches, one double-pole, single-throw, baby knife switch, one extension bell, and one telephone set. This circuit is arranged (fig. 43) with one telephone and signal bell, so that a person at the station may talk on either line by using the

same telephone. The operation of the switches is as follows: Switch 1 closed down, switch 2 open, switch 3 closed—telephone on metallic line direct. Switch 3 open, switch 1 closed down, switch 2 closed down—telephone on grounded line direct. Switch 3 closed, switch 1 closed up, switch 2 closed up—grounded line cut on to metallic line through repeating coil direct, instrument remaining across entire line. This circuit is so arranged that the instrument may be left on the grounded line and the extension bell will ring if a party at this station on metallic line is called. Switches 1 and 2 should never be closed down at the same time without opening 3, as by so doing the metallic line would be made very noisy.

APPENDIX.

FORM OF CONTRACT BETWEEN A COMMERCIAL TELEPHONE COMPANY AND THE SECRETARY OF AGRICULTURE OF THE UNITED STATES FOR TELEPHONE SERVICE IN CONNECTION WITH THE NATIONAL FORESTS.

This agreement, made this ..... day of ....., 19.., by and between ...., a corporation organized and existing under and by virtue of the laws of the State of ..... (hereinafter called the Telephone Company) of the first part, and the Secretary of Agriculture of the United States (hereinafter called the Secretary) of the second part.

WITNESSETH:

Whereas the Telephone Company operates a general public commercial telephone exchange and toll line system, which includes certain exchanges and toll lines located in the neighborhood of certain National Forests under the jurisdiction of the Secretary and situated, in whole or in part, in the territory of the Telephone Company; and

Whereas the Secretary desires to utilize, as an aid to the administration, protection, and preservation of National Forests and in fire prevention and control, certain special telephone facilities which the Telephone Company is able to supply, and the Secretary also desires to procure from the Telephone Company, in connection with fire prevention and control and in the administration of said National Forests, telephone exchange and toll line service; and

Whereas the Telephone Company is willing to furnish for the foregoing purposes, the special telephone facilities and the telephone exchange and toll line service hereinafter mentioned, and is also willing, to the extent and in the manner hereinafter set forth, to cooperate with the Secretary and to enlist as well, so far as possible, the cooperation of the Telephone Company's subscribers in the vicinity of said National Forests, in facilitating and supplementing the operations of the Secretary in fire prevention and control:

Now, therefore, in consideration of the premises and of the covenants and agreements hereinafter set forth, it is agreed by the parties hereto as follows:

Article 1.

The Telephone Company will, as the Secretary may, during the continuance of this agreement, from time to time request:

1. Connect, by telephone line or lines of suitable type, with the central office of the Telephone Company in any exchange then established in any municipality or settlement adjacent to or in the neighborhood of any National Forest, telephone stations in such number, on any one such line, and at such locations, within or adjacent to said National Forest and outside the limits of such an exchange, as the Department of Agriculture may require; equip each such line, at the terminal thereof in such an exchange, with such of the Telephone Company's standard terminal apparatus as will reduce to a practical minimum the chances of central office trouble interfering with the operation of such a line; and furnish thereover local exchange, local toll and long distance telephone service, under the terms and conditions and at the rates set forth in the annexed schedule marked "A" and hereby made a part hereof: *Provided*, That the Department of Agriculture will, at its own expense, equip, install

and maintain, as herein provided, each of such telephone stations, and furnish and maintain, as herein provided, that portion of each such line which may extend to and between such stations and a point, to be designated by the Telephone Company, ordinarily at or near the central office of the exchange with which each such line may be connected or, in case of an exchange operated within a municipality, at or near the limits thereof; the Telephone Company to furnish and maintain that portion of each such line which may extend to and between said junction and the switchboard of the Telephone Company's said central office.

2. Furnish, for use by the Department of Agriculture in equipping any of the foregoing telephone stations, sets of telephones, with the necessary types then furnished by the Telephone Company to its subscribers and lessees in the exchange serving any such telephone station; each such set to be furnished upon the terms and conditions and at the annual rental specified in the annexed schedule "A."

3. Furnish to the Secretary, in addition to the class of service hereinabove described in section 1, in any public telephone exchange then operated by the Telephone Company, such of the Telephone Company's regular classes of exchange and toll line service, and such other service regularly furnished by it to the public, as such exchange may supply, and under the terms and conditions and at the rates expressed in said schedule "A."

4. Furnish without charge, for the attachment of any telephone circuit furnished and maintained hereunder by the Department of Agriculture, space on any of the Telephone Company's pole lines located within any National Forest contemplated hereby or extending therefrom to the nearest exchange of the Telephone Company, or, in case such an exchange is located in the municipality, then to a point to be designated by the Telephone Company, at or near the limits of such municipality: *Provided*, That any such attachments to the Telephone Company's pole lines shall in all cases be made under its supervision and direction, and in accordance with its standard specifications and engineering practices, and then only whenever, in the judgment of the Telephone Company, spare facilities for such attachments exist.

5. Construct for the Department of Agriculture, in, through, and adjacent to any National Forest contemplated hereby, such telephone pole lines as said Department may require for use hereunder; string telephone circuits thereon; install the necessary telephone station equipment to be used in connection with such circuits; keep such pole lines, circuits, and station equipment in repair; and, in cases of emergency, sell to the Department of Agriculture such telephone equipment and line material and supplies as can reasonably be spared from local stock rooms of the Telephone Company; all of the foregoing services to be performed by the Telephone Company for the Department of Agriculture at actual cost, including reasonable and proper charges for supervision, plus ten (10) per cent, and all of the foregoing sales to be made at actual cost at point of delivery plus ten (10) per cent: *Provided*, That the Telephone Company shall not be bound hereunder to begin the construction of any line requested by the Department of Agriculture until the expiration of a reasonable time after the receipt by the Telephone Company of such request, which shall not be less than the time usually taken by the Telephone Company in preparing for the construction of its own lines.

6. Permit the Department of Agriculture, without charge and at its own expense, to attach to and maintain on the Telephone Company's poles, at such reasonable lookout points as may be agreed upon by the respective representatives of the parties hereto, designated as hereinafter provided, lock boxes equipped with sets of telephones, and to connect such sets of telephones directly with the Telephone Company's circuits attached to such poles, with the right to the Department of Agriculture to use such sets of telephones, in cases of emergency only, for telephonic communications over such circuits; and the Telephone Company will also, in such cases, allow the Department of Agriculture to connect its portable emergency sets of telephones,

for like purposes, with the Telephone Company's circuits located within or adjacent to any National Forest contemplated hereby: *Provided*, That the right herein granted to connect such lock-box telephone sets with such circuits may be refused by the Telephone Company when such connection would involve the use hereunder of a toll circuit connecting together any two public telephone exchanges, and that connections of lock-box telephone sets shall be made hereunder with subscribers' circuits only after any necessary consent of other users of such circuits have been obtained. The Department of Agriculture hereby agrees that any connections of emergency telephone sets with the circuits of the Telephone Company hereunder, shall be made by the Department of Agriculture upon its own responsibility, and said department shall hold itself liable to the subscribers and patrons of the Telephone Company for any claims of loss, damage or injury resulting from such connections.

7. Designate local officials or employees to cooperate with the officials or employees of the Department of Agriculture in the work of constructing, equipping, and maintaining any telephone pole lines and circuits, and in the work of installing and maintaining any telephone station equipment, which the Department of Agriculture may undertake to provide and maintain hereunder; furnish engineering and other advice and information, together with plans, drawings, blue prints, specifications, and recommendations with reference thereto; actively cooperate with such officials or employees of the Department of Agriculture in providing emergency communication by telephone during forest fires; and in behalf of and as agents of the Department of Agriculture in securing the prompt delivery of any telegrams transmitted by telephone during such fires to or for any employee of the Department of Agriculture.

8. Keep open at all hours, under special conditions or emergency or public necessity, in any exchanges contemplated hereby, such of the Telephone Company's central offices not regularly open at all hours, as may at such times be designated by the Department of Agriculture, such special service to be performed by the Telephone Company for the Department of Agriculture at the actual cost thereof in each case.

9. Allow any employee of the Department of Agriculture to charge, to any of its telephone stations served hereunder by an exchange of the Telephone Company, any message which such employee may transmit from any lock box or portable telephone set herein provided for, or from the telephone station of any subscriber of the Telephone Company: *Provided*, That if the telephone station accepting such a charge is not the station called for, it shall be a station connected with the exchange at which the call originates.

10. Require its employees to strictly observe all the rules and regulations of the Department of Agriculture relating to the care and protection of the National Forests; exercise due care and caution to avoid injury to growing timber; and give prompt notice to the Department of Agriculture of any forest fires discovered by them, or of which they may receive notice, when engaged in any work in said Forests.

11. Use its good offices in arranging, so far as possible, with the subscribers in or near any National Forest to give prompt notice to the Telephone Company's central office directly serving such subscribers of any forest fires discovered by such subscribers or of which they may receive notice, and instruct its operators and other employees promptly to communicate such notice to the local forest officials.

12. Furnish to the Department of Agriculture maps showing the arrangement and location of the circuits, pole lines, and exchanges of the Telephone Company in the neighborhood of any National Forest contemplated hereby.

13. Use its good offices to secure for the Department of Agriculture, upon terms and conditions substantially similar to those herein provided for, suitable arrangements for the furnishing of service similar to the service herein provided for, by such of the connecting companies of the Telephone Company within its territory as the Department of Agriculture may in each case desire or approve.

14. Extend the telephone facilities and service covered by this agreement to State authorities and private timberland owners cooperating with the Department of Agriculture in forest protection in so far as, in the judgment of the Telephone Company, such facilities and service may reasonably be so extended: *Provided*, That any special rates for exchange or toll-line service set forth in the annexed schedule "A" shall in no case be allowed hereunder to such State authorities and timberland owners for any purposes other than forest protection.

ARTICLE II.

The Secretary will:

1. Upon request, from time to time, when compatible with the public interest, grant or cause to be granted to the Telephone Company, its successors and assigns, easements for rights of way for periods of fifty (50) years from the date of the issuance of such grants, for the construction, operation and maintenance of any telephone lines which the company may have constructed, or may in future desire to construct, over, across and upon any of the National Forests of the United States, or any land under the jurisdiction of the Department of Agriculture, including the right to cut down or trim any trees which may interfere with or endanger such lines: *Provided*, That the grant of such easements to the Telephone Company, under the act of March 4, 1911 (36 Stat., 1235), shall be subject to general regulations issued thereunder by the Secretary of Agriculture in force at the time such grants are made.

2. Permit the Telephone Company, without charge, to attach the telephone circuits of its general commercial-telephone system to the pole lines of the Department of Agriculture, now or hereafter located within any National Forest contemplated hereby or extending from such National Forest to or to points near any public telephone exchange of the Telephone Company: *Provided*, That such attachments shall be made in accordance with the rules and regulations of the Department of Agriculture, and shall be permitted only when and where, in the judgment of the Department of Agriculture, spare facilities exist.

3. Sell to the Telephone Company in accordance with the regulations of the Department of Agriculture for the construction and maintenance of the lines of the company timber from such of the National Forests as are traversed by or adjacent to such lines, when such lines are not necessary for the protection of the National Forests from fire; and furnish to the Telephone Company, free of charge, National Forest timber for poles and other purposes for the construction and maintenance of telephone lines within or adjacent to National Forests, when such lines are necessary for the protection of the National Forests from fire: *Provided*, That no sale or free use of timber shall be made or allowed that would, in the opinion of the Department of Agriculture, be injurious to said National Forests or inconsistent with the purposes for which they are created and administered.

4. Use or require to be used upon all telephone circuits, furnished and maintained by the Department of Agriculture for use hereunder in connection with the exchanges and lines of the Telephone Company, only such telephone transmitters, receivers, apparatus, appliances, equipment, and material as shall in all cases be of a standard approved by the Telephone Company as suitable for the purposes of this agreement.

5. Equip at all times with such protective devices, and keep in such repair and maintain in such a manner as shall conform to the standard requirements of the Telephone Company for the performance of such work by its employees, all telephone transmitters, receivers, apparatus, appliances, equipment, material, wires, and circuits maintained by the Department of Agriculture and used hereunder directly or indirectly in connection with the exchanges and lines of the Telephone Company.

6. Protect, in accordance with the standard specifications and engineering practices of the Telephone Company, from all danger of or exposure to crosses or contact with or induction from high-tension electrical circuits, all telephone circuits maintained by

the Department of Agriculture and used hereunder in connection with the exchanges and lines of the Telephone Company or attached to its poles.

7. Observe, in the use of the telephone stations and circuits furnished or used hereunder in connection with the exchanges and lines of the Telephone Company, all reasonable rules and regulations of the Telephone Company governing the use of its subscribers' stations and not inconsistent with the provisions of this agreement.

8. Permit to the Telephone Company at all reasonable times access to any telephone station equipment or telephone circuit used hereunder in connection with the exchanges or lines of the Telephone Company for making such inspections or such service tests as may be requisite for the purposes of this agreement.

9. Pay, in accordance with the terms and conditions and at the rate set forth in the annexed schedule "A," all charges for local exchange, local toll and long-distance telephone service furnished hereunder by the Telephone Company, and also pay, in accordance with the provisions hereof, all other charges of the Telephone Company for any other services performed hereunder, or for instruments, equipment, material, and supplies furnished to the Department of Agriculture by the Telephone Company.

10. Designate officials and employees with authority to assist and cooperate with the designated officials and employees of the Telephone Company in the construction and maintenance of the telephone lines furnished and maintained hereunder by the Department of Agriculture and in generally effectuating the provisions of this agreement; and with the further authority to requisition or obtain, in behalf of the Department of Agriculture, any telephone circuits, apparatus, appliances, equipment, and material for use in emergencies, the construction, maintenance, or repair of telephone lines used hereunder, or any benefit or thing accruing to or to be derived by the Department of Agriculture under or by virtue of the provisions of this agreement.

ARTICLE III.

It is expressly understood and agreed between the parties hereto that:

1. This agreement does not contemplate the use hereunder, in connection with any regular service of the Telephone Company, of any telephones and station equipment not furnished by it, except in cases of emergency, and the use of any such telephones and equipment is so permitted only in view of the public demand and necessity therefor.

2. No part of the facilities and service furnished hereunder by the Telephone Company to the Department of Agriculture shall be used in connection with any service for which a charge or compensation shall be received or collected by the Department of Agriculture from any person, firm, or corporation, without the express approval and consent in writing of the Telephone Company.

3. No telephone transmitter, receiver, apparatus, wire, or circuit furnished to or used hereunder by the Department of Agriculture in connection with the exchanges and lines of the Telephone Company shall in any case, without its express approval and consent in writing, be connected directly or indirectly with any telephone transmitter, receiver, apparatus, wire, circuit, or service other than that of the Telephone Company, nor shall any telephone station served hereunder by an exchange of the Telephone Company be located outside its territory without such approval and consent.

4. Upon the termination of this agreement, as hereinafter provided, all connections of the telephone circuits furnished and maintained by the Department of Agriculture, theretofore made with the general commercial telephone system of the Telephone Company, may be discontinued and severed by either party hereto, but if, at the termination of this agreement, either party shall desire to continue the attachments made hereunder to the pole lines of the other, such attachments shall be allowed to remain on such poles under such terms and for such rental charges as may be agreed

upon between the parties. In the event that the parties hereto are unable to agree as to the terms or rental charges for attachments other than those covered by specific easements, which may be retained on said poles, as above provided, all questions at issue between them shall be sumbitted to a board of arbitration composed of three members, one to be selected by each party, and the third to be chosen by the two thus selected, and the finding of the majority of such board shall be final and binding upon both parties.

5. The provisions of this agreement shall be binding upon and shall accrue to the benefit of the successors and assigns of the Telephone Company.

6. No Member of or Delegate to Congress is or shall be admitted to any share or part in this agreement or to any benefit to arise therefrom. (Sections 3739–3741, United States Revised Statutes.)

7. This agreement shall remain in force for a period of one (1) year from the date hereof, and thereafter shall be automatically renewed for periods of one (1) year, unless canceled by written notice from either party to the other not less than sixty (60) days prior to the expiration of any one (1) year term: *Provided, however*, That nothing herein contained shall be construed as binding the Secretary to expend in any one (1) fiscal year any sum in excess of appropriations made by Congress for that fiscal year, or to involve the Government in any contract or other obligation for the future payment of money in excess of such appropriations.

In witness whereof, the parties hereto have caused this instrument to be executed in duplicate the day and year first above written.

.....

By .....

Attest:

.....

Secretary.

.....

Secretary of Agriculture.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY SPECIFICATIONS FOR BEST-BEST GALVANIZED-IRON WIRE.

General description.—The finished product desired under these specifications consists of galvanized Best-Best wire as hereinafter specified.

Finish.—The wire shall be cylindrical in form and free from scales, inequalities, flaws, splints, and other imperfection.

The finish of the wire shall be in accordance with the best commercial practice.

Each coil shall be warranted not to contain any weld, joint, or splice in the rod before drawn.

Galvanizing.—The wire shall be well galvanized in accordance with the specifications for the galvanizing of iron and steel hereinafter referred to.

Physical requirements.—The galvanized wire shall conform to the following requirements:

ELECTRICAL REQUIREMENTS.

Electrical resistance.—The resistance of the wire in ohms per mile at a temperature of sixty-eight (68) degrees Fahrenheit shall not exceed the quotient arising from dividing the constant number, fifty-six hundred (5600), by the weight of the wire in pounds per mile.

MECHANICAL REQUIREMENTS.

Dimensions.—The diameter of the galvanized wire shall be within the limits given in the following table:

Gauge number, B. W. G.	Maximum.	Diameter of galvanized wire, in inches.	
		Gauge.	Minimum.
6	0.207	0.203	0.198
8	.169	.165	.161
9	.152	.148	.144
10	.138	.134	.130
12	.112	.109	.105
14	.086	.083	.080

Breaking weight.—The breaking weight of the wire shall not be less than two and eight-tenths (2.8) times the weight of the wire in pounds per mile.

Torsion.—The wire shall be capable of withstanding at least fifteen (15) twists in a length of six (6) inches.

Coils.—The length of wire in each coil shall be as follows:

No. 6 B. W. G., approximately $\frac{1}{3}$ mile.

No. 8 B. W. G., approximately $\frac{1}{2}$ mile.

No. 9 B. W. G., approximately $\frac{1}{2}$ mile.

No. 10 B. W. G., approximately $\frac{1}{2}$ mile.

No. 12 B. W. G., approximately $\frac{1}{2}$ mile.

No. 14 B. W. G., approximately $\frac{1}{2}$ mile.

In the case of wire less than 0.134 inch in diameter one-third ($\frac{1}{3}$) of the coils may have two (2) pieces to a coil joined by the ordinary twist joint carefully soldered and galvanized.

In the case of wire 0.134 inch in diameter and larger, each coil may consist of two pieces only joined by the ordinary twist joint carefully soldered and galvanized.

Binding.—Each coil of wire shall be securely bound in at least four places with galvanized-iron wire. A tag shall be attached to each coil giving the size and grade of wire in the coil.

AMERICAN TELEPHONE & TELEGRAPH CO. SPECIFICATIONS FOR TOLL LINE GLASS INSULATORS.

The material desired under these specifications consists of glass insulators of the style and dimensions hereinafter described.

General.—The specifications and drawings are intended to include all instructions necessary to guide the manufacturer in his work. They are intended to cooperate with and supplement each other so that any details indicated in one and not in the other shall be executed as if indicated in both.

Workmanship.—All workmanship shall be of the best commercial grade.

Material.—The insulators shall be made of transparent colorless or green glass.

Dimensions.—The insulators shall be of the style and dimensions shown in the drawing hereinafter referred to.

Where maximum and minimum dimensions are shown the dimensions shall be within the limits specified. Where limits are not shown the dimensions shall be approximate.

The diameter of the thread shall be such that at least two revolutions of the insulator will be required to tighten it on the standard insulator gauge hereinafter referred to, and when in this position the end of the insulator gauge shall not be more than one-eighth ($\frac{1}{8}$) of an inch from the crown of the insulator.

The thread of all insulators shall be smooth and of uniform pitch. The thread shall be well centered in the insulator so that when in place on the standard insulator gauge, the gauge will not touch the inner surface of the petticoat.

Insulators conforming in all other respects to the requirements of these specifications, but having on the lower edge of their petticoats a series of projecting points, may be accepted under these specifications.

Finish.—The insulators shall have a finish ensuring as far as is consistent with the best commercial practice smooth even surfaces and freedom from flaws, cracks, blowholes, sharp edges, and other defects.

AMERICAN TELEPHONE & TELEGRAPH CO. SPECIFICATIONS FOR POLE LINE BRACKETS.

The articles desired under these specifications consist of oak pole brackets, fitted to take the standard insulator of the American Telephone & Telegraph Co.

Workmanship.—All workmanship shall be of the best commercial grade.

Material.—All brackets shall be made of sound oak, free from knots, checks or cracks, sapwood, wormholes, and brash wood. The grain of wood on all brackets shall be practically parallel to the axis of the threaded portion of the bracket. The grain from the right-angled corner at the end of the bracket shall not run below the bottom thread on the opposite face of the bracket.

All brackets shall be thoroughly seasoned before being offered for inspection.

Dimensions.—The seasoned brackets shall be of the style and dimensions shown in drawing No. 57–E–35. Where maximum and minimum dimensions are shown, the dimensions shall be within the limits specified. Where limits are not shown the dimensions shall be approximate. Figures upon the drawings shall be followed in preference to scale measurements.

Thread.—The threaded portion of the bracket shall be as nearly as possible of a circular cross section. The thread shall be smooth and of a uniform pitch, and such that a standard insulator can be readily screwed onto the bracket until the end of the bracket touches the top of the insulator. When in this position there should be no perceptible rocking or play of the insulator on the bracket.

Nail holes.—Each bracket shall have two (2) nail holes as shown in drawing No. 57–E–35. The nail holes shall be well centered and shall be perpendicular to that face of the bracket which makes an angle with the axis of the thread.

SOLDERING.

Approved Solders.—Approved solders are those made in accordance with the American Telephone & Telegraph Co.'s specifications:

No. 3438 for 40–60 solder.
No. 3439 for 45–55 solder.
No. 3440 for 50–50 solder.
No. 3441 for Resin Flux Wire Solder.

No others are to be used.

Approved Fluxes.—Approved fluxes are:

Plumber's candles for plumbing and cable work.
Resin.
The stick forms of flux made by the Western Electric Co. and that known as "Allens" stick.

No other form of flux, such as paste or liquid soldering salts, are to be used.

45–55 Solder.—45–55 solder is to be used for joining split sleeves in cable work, and for large surfaces of metal which are to be soldered. It is also to be used in

making joints in old galvanized iron wire, and similar work. In joining old galvanized wire, clean the ends which are to be soldered with emery cloth and make a Western Union joint; then solder by means of a ladle, using only as a flux one of the approved stick forms. Do not use more than is necessary to cause the solder to flow and apply by rubbing before the first pouring of the solder over the joint. If necessary, apply again after the joint has been heated. A large wel-ltinned soldering iron may be used, if preferred, instead of pouring the solder over the joint. In such a case the iron must be pressed against the joint so as to warm it just enough to melt the flux when it is held against it. After a coating of this has adhered, apply the hot soldering iron again and, at the same time, the 45–55 wire solder onto the joint (do not put the solder on the soldering iron). When the solder melts, having derived its heat from the joint and not from the iron, it will flow readily. A slight tap on the wire will help it to run into the joint well. This solder is furnished in the form of $\frac{1}{8}$-inch wire in 10-pound coils, or in bars of $1\frac{1}{2}$ pounds weight, and orders must state in which form it is required.

Resin Flux Wire Solder.—Resin flux wire solder is to be used in soldering all wire connections other than galvanized iron wire, but it may also be used for this purpose in new work, when it is done with a soldering iron. It is also to be used for all work where copper and brass are to be soldered. To use this solder for small work, such as wire joints and terminals, apply a well-tinned soldering iron of sufficient size for the work to the joint. In soldering terminals, first clean all old solder and bits of wire off by means of a hot iron and then give only one turn of the wire which is to be soldered around the terminals. In larger work, use any convenient means to heat the joint, remembering to get a coat of resin on before sufficient heat has been applied to the metal to oxidize it and that the metal to be soldered must be hot enough to melt the solder and burn off the superfluous resin. This solder is furnished in 5 and 10 pound coils, and orders must state which size is required.

Tinning Soldering Iron.—File the iron to the required shape and brightness and heat until it is only just hot enough to melt the resin of resin-cored solder, but not hot enough to change the color of the bright copper by oxidization. When in this condition, coat the part to be tinned with resin and apply heat until the solder melts readily, when it will be found to flow freely on the iron. Do not let the flame come in contact with the tinned part of the iron.

ADDITIONAL COPIES

OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
15 CENTS PER COPY

▽

United States
Department of
Agriculture

NATIONAL
AGRICULTURAL
LIBRARY

Advancing Access to
Global Information for
Agriculture